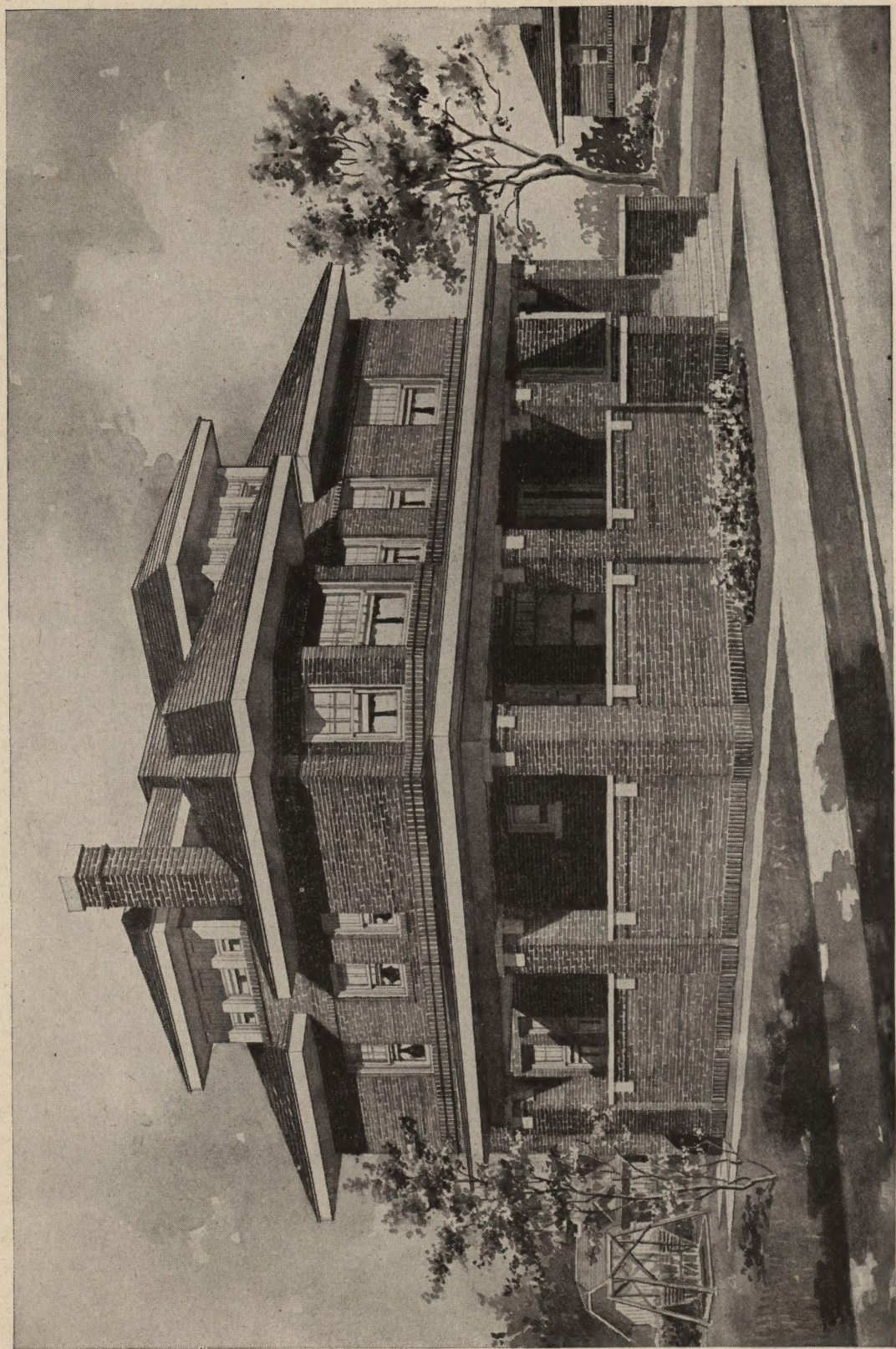




BRADFORD'S BRICK HOUSES

AND HOW TO BUILD THEM



ATTRACTIVE MODERN BRICK RESIDENCE.
For floor-plans, see page 3.

Radford's Brick Houses

and How to Build Them

A STANDARD COLLECTION OF

NEW, ORIGINAL, AND ARTISTIC DESIGNS FOR BRICK HOUSES,
APARTMENTS, STORES AND FLATS, GARAGES, ETC.;
TOGETHER WITH COMPLETE INSTRUCTION IN
THE MANUFACTURE OF BRICK AND
ITS PRACTICAL USES AS A
BUILDING MATERIAL

Selected and Compiled by

WILLIAM A. RADFORD

President of the Radford Architectural Company, Chicago, Ill.; Editor-in-Chief of
"Radford's Cyclopedia of Construction," "American Carpenter and
Builder," and "Dealers Building Material Record"

Every Plan Designed and Executed by a Corps of
LICENSED ARCHITECTS OF THE HIGHEST PROFESSIONAL STANDING,
ASSISTED BY A STAFF OF EXPERT DRAFTSMEN

OVER 300 DESIGNS AND DETAILS

Covering a Great Variety of Modern Types of Brick Construction, Economical in Cost and Representative
of the Highest Art in the Architectural Treatment of Brick

THE RADFORD ARCHITECTURAL COMPANY

178 W. JACKSON BLVD.
CHICAGO, ILL.

178 FULTON STREET
NEW YORK, N. Y.

1912

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BY

THE RADFORD ARCHITECTURAL COMPANY

Preface

A MERICANS are a nation of home-builders. A man's standing in any community is based largely on the kind of house he lives in. If it is his own home, he enjoys an importance that does not attach to the man who pays rent.

In glancing over the brick house designs illustrated in this volume, one may wonder at the marvelous advances made in home architecture in recent years. It is not a difficult stretch of imagination from the makeshift habitations of the early days to the beautiful homes of comfort and luxury shown in these pages; yet it has been a development slow and sure, keeping pace with the advancement of the race along all lines.

Two of the most important factors in this development have been the steady diminution of the country's lumber supply and the public realization of economic losses through fire. Confronted by glaring head-lines telling of fire losses beyond those of any other civilized nation, the American citizen scrutinizes more carefully than ever the building materials offered him.

Of these, during the last ten years, brick has appealed to him with daily increasing force. Born of the fire, brick successfully resists attack from external and internal fire where other building materials would crack, spall, disintegrate, or fuse.

Every brick reflects in a distinctive way the human life which caused it to be. From its digging as clay at the point of the shovel, to its emplacement in the wall at the point of the trowel, in all steps of its manufacture, brick unites man's greatest knowledge and skill in mechanics, physics, and chemistry.

The purpose of this book is to place within the immediate reach of the prospective house-owner, the contractor, the builder, the dealer, and the architect, a cyclopedic review of brick, its history, its classification, its qualities, and its many applications contributive to human safety and comfort. The more this material is studied, the more confidence it receives.

In its cheapest and commonest form, brick adapts itself to the constructive needs of the humblest cottage. The arrangement of the brick in the wall, and a judicious choice of color, will result in artistic effects equal in charm to those obtained in residences built of other materials, though palatial in size, ornate in structure, and ten times as costly.

The plans presented will enable the home-builder in rural communities, in small towns, and in cities, to select a design exactly suited to his domestic requirements and local conditions. In selecting the design of a house, there are a number of factors that should be taken into consideration. The size of the lot, the possible slope of the ground, and the surrounding buildings have much to do with the appropriateness of any design. In other words, the ar-

tistic sense will direct the selection of a design that will be in harmony with the surroundings. These are things that should be considered at the outset, for the selection of the design is indeed the most important feature of the problem. Select a design that assures plenty of room for the needs of the family—present as well as future. It will not be necessary to consider the matter of convenience of interior arrangement, for the architects have solved that problem in every case. Every house is planned from the inside, and not from the outside; that is to say, convenience of arrangement has been the first consideration, and this fact will be appreciated by the wives and daughters.

The location of the house is another important feature. It should not be placed in the middle of the lot. To provide lawn room and a place for shrubbery and flower-beds, the house should be at one side or well back, so that when the lawn decorations are placed the picture will be artistic and the grounds contribute to the unity and harmony of the entire design.

A man who builds a home owes a duty not alone to his family and himself; he is under a moral obligation to the community as well. No man has a moral right to build a house which will be unworthy of the community in which he lives, or which, by its inappropriateness or utter lack of style, will tend to depreciate the value of property in the neighborhood. In house building, as in all other things in which men engage, the purpose should be improvement and betterment. So we advocate only a house built from accurately drawn plans—a house with “style.”

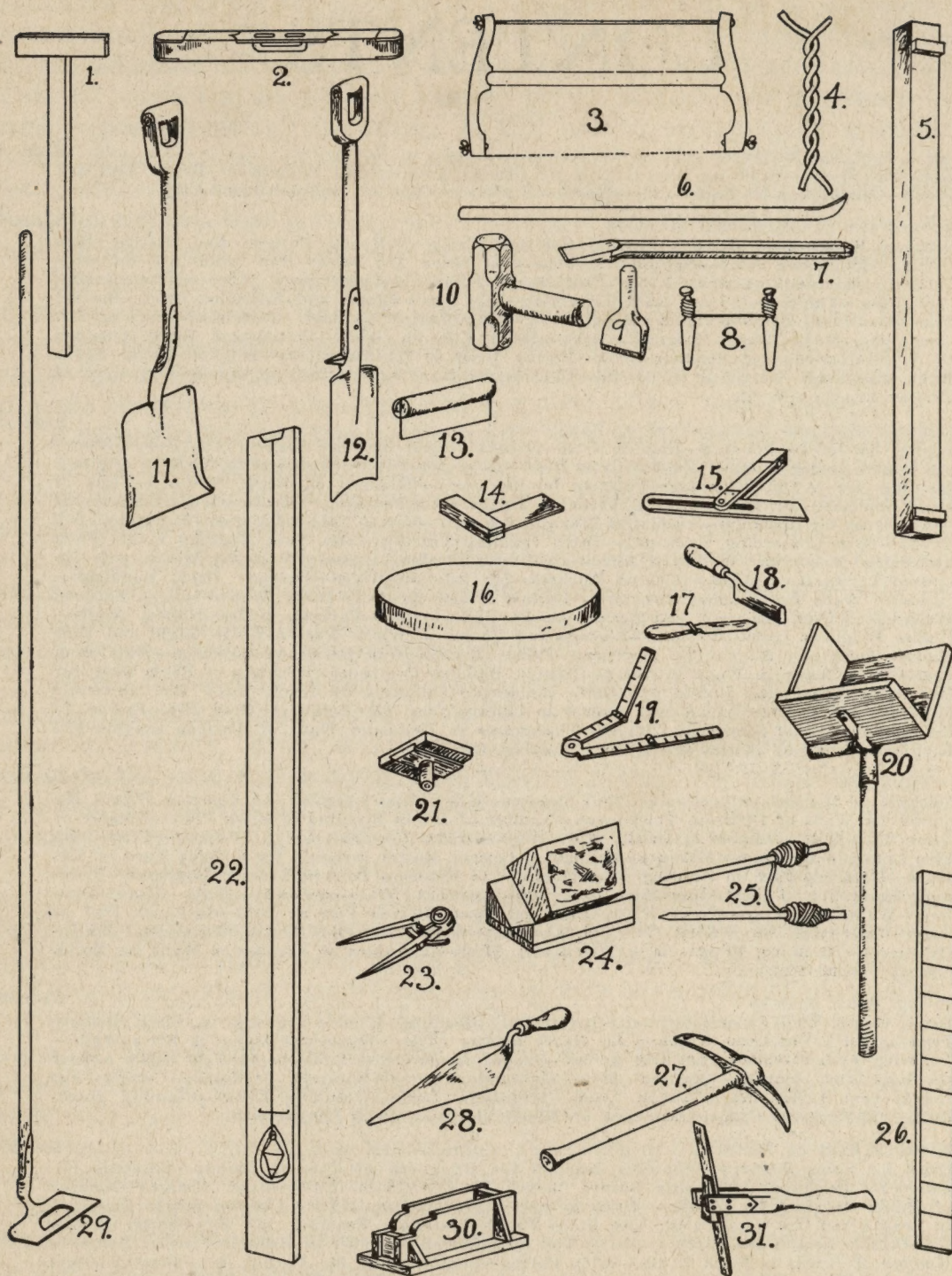
As the house may be the habitation of the family for life, no greater calamity in a material way can befall the owner than to discover, when the house is complete, that it is faulty in arrangement or in appearance. This is apt to be the case with a house built without plans. On the other hand, it is a source of constant joy and satisfaction to live in a house which is built from accurately drawn plans, and which is worthy of the neighborhood.

Let us impress upon your mind one vital thing. NEVER build a house without plans to work from. It is hardly necessary to tell you that no more foolish thing is ever done by a man than to try to build without plans, or—which is just as bad—from rough pencil sketches. We could show you in our files thousands of letters from persons who have ordered plans after failing miserably in their efforts to build without accurate drawings. Here are some of the things that happen to the man who tries to build without plans: His house lacks style, that peculiarly pleasing aspect that is possible only in a house built from an accurate design. He wastes materials. He wastes the time of his workmen. He wastes nervous energy in worry over mistakes; and, when the house is done, if it ever be, he has a monstrosity that people laugh at as they go along the street. This window will not be square; that floor will not be level; and—worst of all—the owner himself will be dissatisfied with the structure.

Every design in this book is drawn with a faithful regard for mathematical accuracy, and there is no error to bother the builder. It is safe to say that the saving in materials that will result from building after any of these plans, will more than pay the price asked for them.

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A BRICKLAYER'S KIT OF TOOLS

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Radford's Brick Houses and How to Build Them

BRICK AS A BUILDING MATERIAL

Historical Sketch

OF all building materials, brick is the one that in all ages, so far as we can search historical records, has been given greatest honor for utility and durability. Indeed, the records of the very earliest times among which we search have been preserved to us on bricks of burned clay. In recent years bricks have been unearthed which are older than the oldest pyramids. In the earliest Biblical days—as far back as 2500 B. C.—the brick-makers and bricklayers had no fear of their product not standing a compression test, for they said: “Go to, let us make brick and burn them thoroughly,” and “Go to, let us build us a city and a tower, whose top may reach unto heaven.” They had great faith in the strength of the brick in the bottom courses.

Seventeen hundred years before Christ, the Israelites commenced a 300-year manual training course in the art of making brick and mortar in Pharaoh's School of Pyramidal Construction. They learned as a nation the sin of making poor brick, for they quit Egypt in a hurry when told to make brick without straw. In the tombs of Thebes may still be seen pictures of laborers tempering the clay, laying the brick to dry on the ground, and gathering them together for the burning.

The art of brickmaking varied but little in its mode of operation, until the introduction of machinery. Could we resurrect some of Pharaoh's unwilling scholars, they would not feel strange

if set to work making brick in the small American hand-brickyard of to-day.

According to Herodotus, the walls of Babylon were built of brick made from material excavated from the trenches surrounding the place. The American expedition of the University of Pennsylvania, excavating in the ruins of ancient Nippur, discovered midway in the mound of the Temple of Bel a platform of huge bricks stamped with the names of Sargon of Akkad and his son Naram-Sin, who lived in 3800 B. C.

The palaces of Nebuchadnezzar have for many years provided brick for all new buildings in their neighborhood. The city of Hillar, with about 10,000 inhabitants, built close to the ruins of Babylon, is practically constructed in its entirety from the brick taken from them. Layard, the great French explorer, says: “To this day, there are men who have no other trade than that of gathering brick from this vast heap, and taking them for sale to neighboring towns and villages, and even to Bagdad.” Many of the brick are coated with a thick enamel or glaze, whose colors have resisted the ravages of time and still retain their original brightness. An average-sized brick used in the construction of the pyramids, was 16 by 3 by $4\frac{3}{4}$ inches.

The unburned brick were called “teba,” which is also the word for a chest or box, and which was given to them by association with the shallow wooden boxes wherein they were made

and from which they were turned out.

The Great Wall of China, the most remarkable structural fortification ever raised by man, was built of burned and unburned brick. For ten years, millions of men were employed in its construction. It was 1,250 miles in length, and its walls averaged 22 feet in height and were wide enough for six horsemen to ride abreast. It is without doubt the biggest brick contract on record.

Burned clay bricks were not common in Greece, owing to the abundance of stone. Here, however, brick were used in many minor public edifices.

Prior to Nero's time, Rome and other Latin cities used wood as a building material in large measure. This is inferred from the quick and disastrous spread of fires. After the destruction of Rome in A. D. 64, brick were employed extensively in its rebuilding. To the Romans is credited the construction of the first brick kilns. The Roman construction was mostly concrete with a brick veneer.

After the Roman empire had passed, the art of brickmaking was almost lost to Europe, people being content to use over again the old material from monasteries and other buildings which, under the changes of stirring times, had been sacked or abandoned.

Only in the 14th and 15th centuries did brick again begin to come into its rightful heritage of public recognition. England and Italy in the 16th century produced beautiful specimens of brickwork. The ecclesiastical and palatial architecture of Italy was specially noteworthy because of its colored decorative brickwork and its moldings and ornamentation in terra-cotta and brick. The great fire of London in 1666 taught the Londoners the value of a fire-re-

sisting material, even as it had done the Romans in Nero's time. All Europe has been educated in a similar manner. We apparently have our lesson to learn yet, for our fire loss is eight times greater than that of Europe.

Holland, lacking stone, has used brick for buildings and for paving its streets, from the first years of its history. The Dutch first introduced brick buildings into America. In 1633, Governor Van Twiller erected on Manhattan Island his private residence, the most elaborate at that time on the continent. The brick were brought from Amsterdam with but little breakage in transit. Some of the old Dutch houses in New York, built of the strong brick from Amsterdam, are still to be seen.

The first brick made in this country were produced at New Haven, Conn., in 1650. Brick was a favored material in Pennsylvania in 1685. Until the rupture between the colonies and the mother country, most of the brick used were imported from England. Brick were carried as ballast to round out light cargoes, and a crude home product was therefore not in demand.

In 1840, Nathaniel Adams invented the first power-brick machine used in this country. Since that time, the brick industry the world over has grown mightily, and the product has justified the confidence placed in it.

From the time the first rain fell on earth, the first men learned the plasticity of clay, as their feet molded the rich clay into foot-shape. When they pushed up the mud into a kind of hearth to raise their fires from the storm-soaked soil, the action of the fire on the clay beneath it was noted, and the burned lumps of clay were used in their initial attempts at home-building. Regularity of form was next seen desirable,

and secured. The brick shape evolved. Brick became a synonym for things durable and substantial. Even to-day, the teaching of ages is incorporated in the compliment we pay a man when we say "He is a brick."

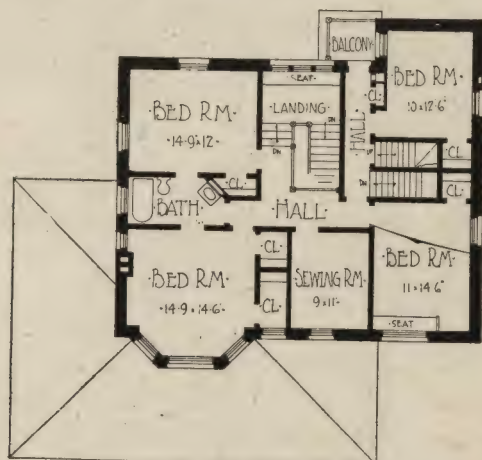
BRICK THE BEST MEDIUM FOR GENERAL ARCHITECTURAL EXPRESSION

Architecture is the structural unison of Service, Symmetry, and Seemliness. With all materials provided by Nature, true architects have accomplished this unison. With some materials, it is much more difficult than with others,

More so than any other building material, brick is serviceable because of its age-long endurance. The earliest records of human history have been preserved to us on bricks of clay, the only survivors of and testifiers to the activi-



First-Floor Plan.



Second-Floor Plan.

FIG. 2. FLOOR-PLANS OF HOUSE SHOWN IN PERSPECTIVE IN FRONTISPIECE OF THIS VOLUME.

to effect a perfect and proportionate combination of these three qualities. Brick offers itself confidently to the American architect, dealer, contractor, builder, and house-owner, as the material best adapted to effect a harmonious constructive blending of Service, Symmetry, and Seemliness.

Brick is serviceable at every stage of construction. Its size has been practically uniform in all progressive countries for centuries, always limited by the size of human hands and the length and strength of human arms. The dimensions of brick make it perfectly adaptable to every form and size of construction.

ties and glories of the peoples who witnessed their manufacture and profited by their use.

Brick is serviceable because more nearly fireproof than any other constructive material. Of all materials offered to the builder, brick is the only one that has been submitted to an actual fire-test in its manufacture. Subjected as it is to a white heat for several days in order that its parts may be securely welded together and its form made enduring, it will be readily understood that it is practically immune from injury by ordinary conflagration.

Because it is weather-proof, retains its color so that it does not have to be

RADFORD'S BRICK HOUSES



FIG. 3. FINE EXTERIOR OF A COMMERCIAL BUILDING.

Showing special treatment of piers and pillars with pressed brick, and revealing some of the possibilities of brick as a medium of general architectural expression.

painted, and does not require repairing, well-made brick is the most serviceable building material that you can select.

Symmetry of construction is as necessary in a residence or other private or public structure as it is in an animal. To the architect and builder falls the task of duly proportioning the several parts of the structure to each other. Brick, again because of its size and facility of handling, enables the architect and builder to embody their proportioning in closest calculation, without hesitancy.

"Seemliness" in architecture may sound strange to the reader's ear, but the term has been chosen advisedly. The word "beauty" has been too freely used, so that it has lost much of its meaning. The root-formation of the word "seemly" has always meant in all languages—to honor, to befit, to satisfy, to be becoming. Seemliness in architecture will permit beauty of design without extravagance, and conformable to the harmonious requirements of environmental setting. The house that charms, whose memory lingers longest with us, is that one which seems to have taken root in the soil on which it rests, and to focus, as it were, all the charms of its surroundings. Brick, through its material, offers to designer, builder, and dweller the means to obtain perfection of seemliness under all conditions of environment.

During the past decade, brick manufacturers have emphasized one important word in their literature—"texture." The slavery to uniformity of color in brick walls has been abolished with that of having to hang all pictures in the rooms in pairs. Nature's most progressive phases of expression are polychromatic—that is, give play to variation in color schemes. The an-

cients knew and practiced brick texture. The mind and eye of the weaver of fabrics were coupled with the hand of the brick mason, and many of their structural triumphs have remained to instruct and stimulate us. Brick walls, with their thousands of brick-units, offer to the architect and builder a broad opportunity to weave therein their finest conceptions of design and color.

BRICK CLAYS AND COLORS

Bricks have been used as building material for many centuries, and no known substitute seems likely to make them less popular. They are durable, of good appearance, and comparatively cheap. The fact that brick masonry is but little affected by the chemical agents that often destroy stone, is well known. As heat is used in the manufacture of brick, such material is well able to withstand the attack of fires that would destroy granite. While stone is no doubt preferred by many for its appearance, very pleasing effects may be obtained from the use of brick, and at considerably less expense.

Brick may be defined as a variety of artificial stone produced by baking clay. While made in a great many shapes and sizes, the blocks are generally of rectangular cross-section approximately $8\frac{1}{4}$ by 4 by $2\frac{1}{4}$ inches on the three sides. These small and regular dimensions are factors that make handling, transportation, and laying comparatively easy. No slow and expensive dressing is required; no heavy hoisting apparatus is necessary for loading; and the separate loads can be made greater or smaller as occasion requires.

Composition of Brick. Brick, as already noted, are made from clay; and the great variety in physical condition and chemical composition of clays en-

ables man to manufacture brick suitable for his every requirement.

Clay, in its purest form, is known as **kaolin**, and consists almost exclusively of alumina, silica, and water. Kaolin is the clay from which the highest grade of white porcelain ware is made. This purest clay is supposed to have been formed by the decomposition of feldspar rock. Its composition is generally stated as 46 per cent silica, 40 per cent alumina, and 13 per cent water.

Similar decompositions of other rocks containing silica, alumina, lime, iron, magnesia, etc., and the blending and mixing of all these elements and compounds under varying influences of glacial and water action and changes of temperature, have given us a range of clays yielding to the manufacturer products as widely variant as the white porcelain cup or vase and the "dinas" firebrick, which is mostly silica bonded together only with a small quantity of milk of lime or of clay.

Common clay, chiefly used for making the different grades of building brick, from "backing" or inside brick to front brick, is composed of silica, alumina, mixed with oxide of iron, lime, magnesia, and other impurities.

Silica, if not in too great proportion, makes the brick burn with less warping than would otherwise be the case. Too much uncombined silica (more than 25 per cent) tends to make the product brittle. Lime in excess has a bad effect by causing the brick to change shape or swell in the burning and to show a tendency to disintegrate after they are burned and exposed to the atmosphere. Iron produces strength, and its presence is indicated by the red color. Usually the red brick are—like the red varieties of stone—the stronger.

To produce **firebrick** a more nearly

pure clay is necessary. A fireclay may be regarded as a variety of impure kaolin, a rough analysis averaging 60 per cent silica, 20 per cent alumina, and small but important proportions of lime, potash, and soda. Iron is in this case not desirable; and the amount of lime, soda, potash, and magnesia combined should not exceed 6 per cent. Silica may be in excess if the property of resisting heat be the only consideration.

Color of Brick. The color depends upon the composition of the clay and the amount of heat applied in burning.

In general, oxide of iron and lime are the controlling factors in determining the color of brick. Magnesia is found in smaller quantities in common clays, and exerts a coloring influence similar to that of lime.

Broadly stated, the red color of clay products is due to the presence of iron oxide; and the white, cream, or yellow, to the presence of lime or magnesia, or both.

Seger's classification is that clays

(a) Rich in alumina, poor in iron compounds—burn white or cream color.

(b) Rich in alumina (20 to 30 per cent), moderate amount of iron (1 to 5 per cent)—burn yellow to brown, as most plastic clays and fireclays.

(c) Poor in alumina, rich in iron compounds—burn red, violet, or black, according to temperature.

(d) Poor in alumina, but rich in iron and lime compounds—burn yellow owing to the formation of the double silicate of calcium and iron.

The conditions of firing also affect the color of goods, as is markedly shown where clays containing iron compounds, and burning red in an oxidizing atmosphere, will, in a reducing

atmosphere with low air-supply, burn black or blue.

Clay containing constituents tending to produce a red color will become darker as more intense heat is added. Heat alone will not produce this effect, as is shown in the light-colored fire-bricks.

In some processes of manufacture, sand is applied to the forms or moulds, to prevent the wet paste from sticking to them. If, as often happens, this sand is red, the brick that might otherwise

be of light tint takes the color of the sand rather than that of the clay, and the outside is red.

The ordinary clay in this country suitable for brickmaking, is mostly glacial material that has been washed down by the streams and redeposited, while its character has undergone little or no change. This is called **alluvial clay**, and the larger pebbles and grains of gravel have been left behind by the stream while the fine clay was in suspension.

MANUFACTURE OF BRICK

The word "brick" as commonly used, is understood to refer to blocks of clay molded to required shape and size by hand or machine. Until recent years, all bricks were made of clay. The manufacture of blocks of similar size and shape, from sand and lime and cement, has brought into the market **sand-lime brick** and **cement brick**. Of these two kinds of brick the sand-lime brick has been adopted by the clay-brick men, owing to some similarity of material and a marked resemblance of manufacturing processes. The cement brick, on the other hand, has materials and manufacturing processes resembling those of cement blocks and other cement products; and a consideration of their use and suitability for specific work will be found in works devoted to cement subjects.

A well-understood commercial classification of clay building brick is: **Common brick**, **Face-brick**, and **Firebrick**. Common brick are brick used for ordinary exterior and interior construction. Face-brick have a name that is self-explanatory, and include the best bricks of all types made by various processes and machines, whether soft-mud, stiff-

mud, dry-press, sand-lime, paving brick, or firebrick (when the two last named are used for building purposes in exterior wall construction). Fire-brick are used wherever there is a fire

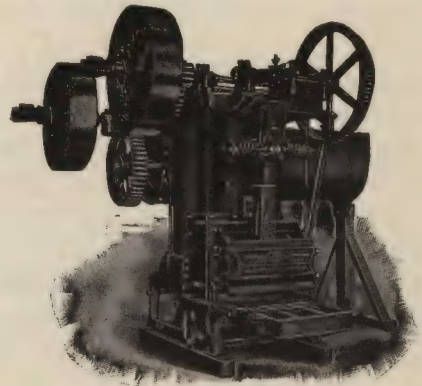


Fig. 4. A Soft-Mud Brick Machine.

hazard, as in chimneys, flues, fireplaces, etc.

Brick of all three classes mentioned above, are made by three different manufacturing processes—namely, the **soft-mud**, the **stiff-mud**, and the **dry-press**.

Soft-mud brick are manufactured either by hand or by machine. The clay is dug from the clay bank, and thrown into pits about 6 ft. deep and

8 by 12 ft. in area. The pits are lined with planking. In the pit, sand is added if needed, and sometimes sawdust, coal dust, or screenings, to assist

mold are emptied onto a board or "pallet," and are borne thereon to the drying ground, shed, or building.

When the molds are dipped in water to prevent the brick from sticking, the product is known as "slop brick." When they are dipped in sand for the same reason, the resultant brick are termed "sanded" brick. Slop brick are deficient in color, in many clays; and in all cases have smoother surfaces than ordinarily found in soft-mud bricks; they also have rounded edges and corners. If the sand used with the sand-struck brick is selected for the purpose, as it generally is, the surface of the brick is neither marred nor enhanced by the sanding.

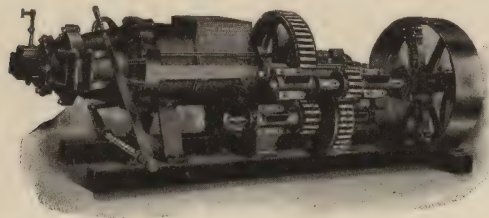


Fig. 5. A Powerfully Geared Stiff-Mud Brick Machine.

the brick in burning. Water is turned onto the clay, which is left to soak for 24 hours. In hand yards, the mixing is done in a circular pit by means of a tempering wheel operated by sweep and horse. The clay is thrown into molds so as to fill them completely and evenly, an operation requiring both strength and skill.

In the manufacture of soft-mud brick by machinery, the clay is taken from the pit and delivered by belt or barrow to the top of the soft-mud machine. A vertical shaft equipped with knives, in revolving, mixes the clay and forces it down toward the molds, to which the clay is then delivered by horizontal blades, an up-and-down plunger ramming the soft mud firmly into the mold-

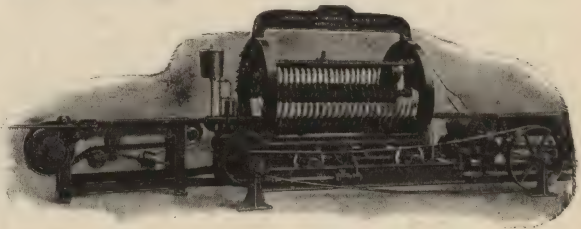


Fig. 7. A Stiff-Mud Brick Cutting Machine.

In the **stiff-mud process** of manufacturing brick, the soak-pit is eliminated. With less water, time and fuel are saved. The preparation of the clay is accomplished by means of crushing and disintegrating machinery, known as pulverizers, crushers, rolls, etc.; and then water is added during the passage of the ground clay through the length of a pug-mill or mixing mill. Revolving knives in this mill, pug the clay to a rich, stiff mud, and pass it forward into the brick machine. This contains an auger and auger-knives. The knives feed the clay to the auger, which presses it out in a clay column through the die required; and are cored to make hollow at the mouthpiece of the machine. The desired, according to the product re-

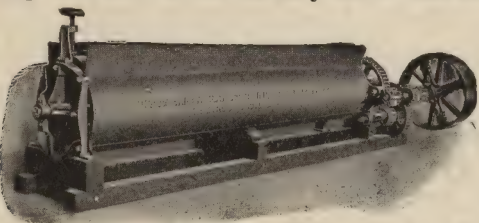


Fig. 6. A Clay Pugmill or Mixing Mill.

divisions. The mold is then removed, and the surplus clay "struck" from it, another mold replacing it immediately and automatically. The brick from the

ies are made to any shape and size

brick, block, or fireproofing tile. The clay column is received by a special cutting table, upon which the bar of clay, while in motion, is cut to the proper size by wires. If the width of the column is the width or thickness of the brick, then the cut is made at the ends of the brick, and they are called **end-cut**. If the width of the column is that of the length of the brick, then the cut is made at the sides of the brick, and they are known as **side-cut**. The brick are removed from the cutting table by an off-bearing belt, from which men load them on trucks or cars for the driers. The mining of the clay for stiff-mud brick is done by digging, by scraper, or by steam shovel, according to the character of the clay and the capacity of the plant.

Re-pressed bricks are stiff-mud or soft-mud brick that have been re-pressed in a special plunger-and-mold machine, with molds slightly larger

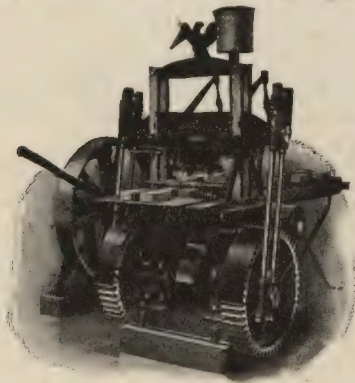


Fig. 8. A Brick Repress.

than the brick, allowing for adjustment in the formation of sharp corners and edges and smoother faces. This method is used for securing a special stock of face-brick, and removes the roughness caused by the wires in cutting the stiff-mud brick. In spite of many arguments claiming increased density, impermeability, and structural strength, tests

have not revealed such advantage, and the gain by re-pressing is in appearance only. Soft-mud brick are re-pressed after they have dried out considerably and can be handled in safety. Few soft-mud brick are re-pressed (most of them being firebrick), in comparison with stiff-mud re-pressed brick.

The **dry-press process** of manufacturing brick has produced the highest

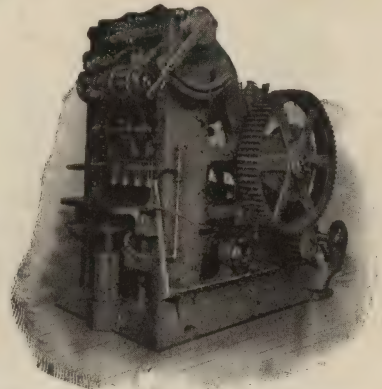


Fig. 9. A Dry-Press Brick Machine.

grade of building brick, when form, color, and strength are considered in combination. The clay used contains only 5 to 8 per cent of moisture. It is mined by hand, by scraper, or by steam shovel. It is generally stored in huge sheds so that a dry supply may always be available, no matter what the weather conditions, and also for the gain to the clay by weathering and "aging." Sometimes it is taken direct to the dry pans. In this machine, huge rolls revolve over a perforated or slotted base-plate, through whose openings the clay falls into the buckets of an elevating belt. These buckets dump the clay onto a screen above, which passes the fine particles, the coarse ones returning to the dry pan. The screened clay is again mixed, and then fed to the molds of the dry-press machine. In this, a charging device carries the clay over and into the steel molds, whose bottom

sides consist of plunger-heads. When the charger is out of the way, upper plungers descend and fill the molds. Thus the clay is subjected to enormous pressure between the upper and lower plungers. At the end of the pressure, the upper plungers reascend, and are followed in their motion by the lower plungers, which push the formed brick to the top of the molds. The brick are

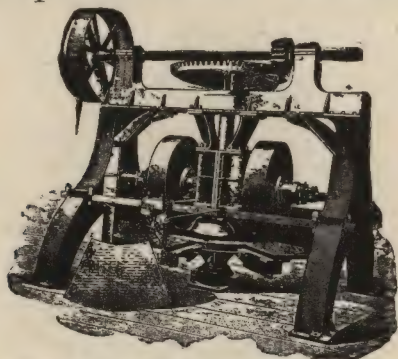


Fig. 10. A Dry-Pan for Grinding Up Tough Clays and Shales.

removed to brick barrows, and the operation is repeated.

All molded and ornamental brick are made in the same manner, the molds being constructed accordingly. If the clay becomes too dry, it is moistened to the proper consistency by a jet of steam before entering the molds.

Dry-press brick do not need to be dried. They can be burned immediately after molding. Only in special cases are they dried, and then for the purpose of varying their color in burning. Dry-press brick are made principally for face-brick. With some clays, however, the dry-press process is the most suitable for the manufacture of common brick.

How Brick are Dried. Brick are dried in the open air on the ground, in the open air under roofs and on racks, and in special drier-buildings using direct heat or steam heat to dry out the brick.

The first method is crude and used only in the smallest plants. The second is widely used in small plants operating only during the summer or under exceptional climatic advantages. Artificial drying is, however, the most favored, the most economical, and insures speed and uniformity of production. In artificial driers, the moisture expelled by the heat is removed by tall stacks or by induced draft. The heat is also frequently introduced by fan and distributed by flues.

When dried by nature, brick require from 5 days to 3 weeks for drying. Artificial driers generally accomplish the result in 24 to 30 hours.

How Brick are Burned. The burning is the crucial test of clay quality and human skill. Brick, perfect in shape and composition as they emerge from the drier, may be ruined in color and shape by mistakes in the firing. Under the action of fire, clay loses plasticity, and its particles are fused together in enduring form.

Brick are burned in **kilns**, of which there are three main types—**up-draft**, **down-draft**, and **continuous**.

Up-draft kilns are either temporary or permanent. Temporary up-draft kilns are formed of the dried brick

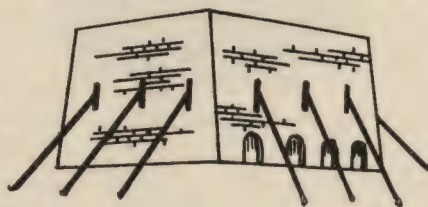


Fig. 11. Old-Style Up-Draft Kiln.

themselves, built up in piles 30 to 50 ft. long, 20 to 35 ft. wide, and from 12 to 18 ft. high. In beginning to build the pile, the lower half is constructed in the form of a series of arches stretched clear across the kiln. Above these



FIG. 12. HANDSOME PRESENTATION OF PRESSED BRICKWORK DETAIL AT OFFICE ENTRANCE.

arches, the brick are set solid. The arches are designed to carry the fire clear through the kiln. As a general thing, the fire is started with wood, and finished with coal; but where wood is cheap, that fuel is used throughout. Firing is also sometimes done with coal entirely. The heat in the arches rises upward through the body of the kiln; hence the name "up-draft." The outside walls of the kiln are daubed with mud to retain heat, and the tops are also filled over. The entire kiln is torn down at each burning.

Permanent up-draft kilns have permanent walls and firing places. The

walls are from 12 to 16 in. thick, and the brick are laid in mortar. The fuel

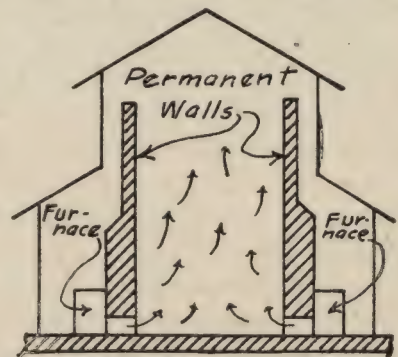


Fig. 13. Up-Draft Kiln with Permanent Walls.

is confined to the furnaces, only the flames and the heat entering the kiln. The tops of these kilns are formed of

"plattling," consisting of burned bricks sealed with mud. This covering is the only part of the kiln removed after each firing.

Down-draft kilns are built circular or rectangular, and have permanent walls and roofs. A type of the circular down-draft kiln is shown in the section in the illustration (Fig. 14). As

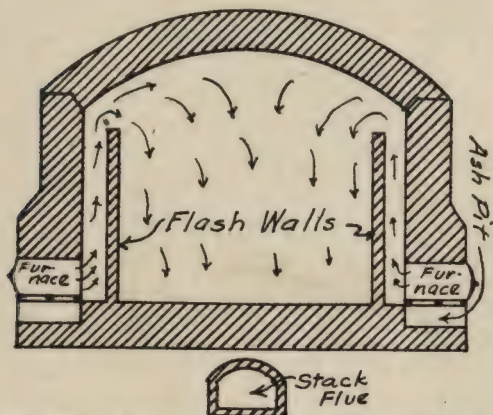


Fig. 14. Section of Circular Down-Draft Kiln.

will be noted, the heat is generated in the fire-boxes, and passes into the kiln through the vertical flues or "bags."

Striking the roof, the heat is then drawn down through the brick, through openings in the floor, into the stack flue shown beneath the kiln, which leads to the main chimney. In all down-draft kilns, there are many variations in flue and floor construction, but the down-draft principle is the same.

A **continuous kiln** is a series of down-draft kiln chambers arranged in a continuous and circular manner. The heat is continuously maintained in some sections of the kiln. The most common form is that of two parallel tunnels connected at the ends. The firing in the first section is started by means of a temporary furnace in the side of the chamber. After the heat has been raised, the side is closed, and further fuel is fed down into the brick through

vertical flues built while setting the brick in the chamber. When the brick in a chamber have finished burning, their cooling heat is not wasted as it is with the up-draft and down-draft kilns, but is led into the next chamber to start the firing of the brick therein. Each chamber has small holes in the top, provided with iron covers, through which slack coal is fed in small quantities. In continuous kilns, there are always some sections being filled, some burning in different stages, and some being emptied or "drawn." To pull the fire from section to section in this way, requires a powerful draft; and this is generally furnished by a tall stack.

Economy of fuel and uniform excellence of production are claimed to be the chief advantages of this form of kiln. The initial investment is great as compared with the down-draft or up-draft types.

Semi-continuous kilns partake of peculiarities of construction of both down-draft and continuous. In tunnel-kilns, the brick are set on cars, which form the bottom of the tunnel and tightly seal it. The fire is always at the same place, and the brick are carried on the cars toward the fire and through it, the brick cooling before they reach the tunnel-end. Only a few kilns of this type are in operation in America.

The burning of the brick may be divided into three stages—**water-smoking, half-fire, and full fire.**

The water in the brick is slowly driven off by gently raising the heat in the kiln during the water-smoking stage. As long as steam or "water-smoke" is seen escaping from the top of the kiln or from the chimneys or stacks, a low heat must be maintained. When this has disappeared, much of the danger of checking and deformation has

passed. The fire is then raised with greater speed, depending on the nature of the clay. When the red glow is seen to be uniform throughout the kiln by means of the peep-holes, firing is then carried steadily on to the end. If carried too fast, the fire will melt the brick

The burning of brick usually requires from 5 to 7 days, according to the clay used.

Paving Brick. "Paving brick" was formerly the name given to any very hard, ordinary brick suitable for paving purposes. The development of the



FIG. 15. ATTRACTIVE PRESSED BRICK FACE-WALL AND WINDOW TREATMENT ON LARGE STORAGE BUILDING.

together. Shales and fireclays stand a much higher heat than ordinary clays. Paving brick made from shales are raised in the kiln to a degree of heat in which they are vitrified, and become as glass, practically impervious to moisture. Great care is taken in their cooling so that they may anneal and possess the requisite toughness.

paving-brick industry, however, since 1890, has set a standard through more complete tests than given to any other clay product, in which vitrification and toughness are qualities which must be possessed by the paving brick or block. Because of their extremely low absorption and their toughness (insuring small loss in handling and shipment), and



FIG. 16. GANG OF MEN LAYING BRICK PAVEMENT ON SAND CUSHION.

also because of their dark color, resembling brownstone, paving brick and paving block have become popular as a building material. They are principally made from a shale clay by the stiff-mud process. Paving brick and block are favored not only on account of their color, but also because they are not subject to efflorescence, they are not attackable by acids or gases, and every rain washes their exposed faces clean.

Paving brick in their manufacture follow the same course as other stiff-mud products. Owing to the toughness of the shales from which they are manufactured, the machinery used is of the most substantial character.

Firebrick. Firebricks are made principally from a mixture of raw flint

clay and plastic clay. There are as many kinds of firebrick as there are uses therefor. They may range in price from \$14 to \$100 per thousand.

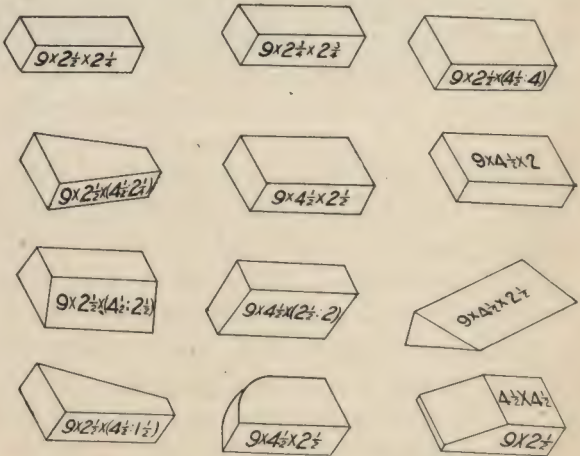


Fig. 17. Some of the Many Stock Shapes of Firebrick.

In building ordinary residences, no very high temperatures are to be provided for; and a well-made firebrick of ordinary grade and price will meet all refractory requirements.

Firebricks are manufactured by all three processes—soft-mud, stiff-mud, and dry-press. It is maintained by experts in the manufacture of refractories, that the soft-mud hand-molded brick is the most perfect product.

Firebricks should have an open grain, and should be porous so that they may absorb and lose heat rapidly. Their composition should be homogeneous; they should be regular in shape and uniform in size.

Firebricks in color are cream, yellow, or brown. They are made in immense variety of sizes and shapes, to meet special commercial applications. The size of the ordinary firebrick is 9 by 4½ by 2½ in., and its weight approximates 7 lbs.

Firebricks which are to be exposed to heat should be laid in fire-clay. The mortar joint should be very thin, and the brick thoroughly wetted before laying.

Fire-Clay. A good fire-clay contains from 50 to 80 per cent of silica, and from 18 to 35 per cent of alumina. It should have a greasy feel, and be of uniform texture.

Fire-clay is not a cement. It is of practically no value as a binder. Its only mission is to fill the voids, and prevent the passage of hot gases or flame. The most perfect firebrick joint is the one which allows just sufficient fire-clay mortar to fill the voids without preventing the brick from touching. The proper method in setting firebrick is to dip the brick one by one into a fire-clay mixture of the proper consistency, and rub or shove the brick in-

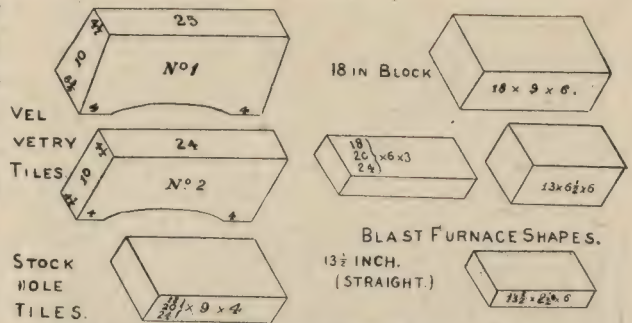


Fig. 18. Velvetry and Stock-Hole Tiles and Blast-Furnace Shapes.

to place, driving it home with the mallet until it touches the brick below it.

Fire-clay as a binder has two serious defects. It shrinks in drying, and has no cementing power. The shrinkage can be reduced by mixing with the clay firebrick flour, secured by finely pulverizing firebrick and sifting it. The right proportion would be 5 parts of fire-clay to 1 part of firebrick flour.

Fire-clay may be given a cementing value by slaking into it a small quantity of lime. Measure the clay; and for each cubic foot, allow a piece of lime the size of an eighth of an ordinary straight firebrick. This enables the clay to take a strong grip on the brick.

All firebrick work should receive, when finished, several coats of fire-clay wash.

To lay 1,000 firebrick, there will be required about 700 lbs. of fire-clay.

No firebrick work should be heated suddenly; the moisture should be expelled gradually, in order to make sure of a perfect job.

A 9-in. firebrick contains 100 cu. in. Six 9-in. brick will make one square foot of face wall, and 54 will lay a square yard of face wall.

Glazed and Enameled Brick

Although these terms are commonly used to designate any and all bricks having a glazed surface, there is quite

a difference in the method of manufacture and the quality of the two products.

A **glazed brick** is made by applying a layer of clay composition to the surface of the unburned brick which is



Fig. 19. Decorative Treatment of a Store Front in Enameled Tile.

to receive the glaze, and then covering this layer in turn with a coating of fusible material which melts at a high temperature, leaving a transparent coating over the layer of clay composition. The color of the under coating of composition gives the color to the brick or glazed face.

In **enameled brick**, the fusible enamel coating is placed directly upon the

brick, and, in burning, becomes a part of the brick. As a general thing, bricks which are to be enameled contain considerable fire-clay. In this type of coloring, the color is due to the enamel coating in itself.

If it is desired to distinguish between a glazed brick and a true enameled brick, a broken corner readily shows the difference. In the glazed brick, the layer of clay composition shows in the break, while no line will show in the case of the enameled brick.

The sizes of enameled brick vary from the English size of $9 \times 4\frac{1}{2} \times 3$ inches to the size of the standard American brick.

The manufacture of glazed and enameled brick, in their first stages, differs but little from the manufacture of pressed or stiff-mud brick already described. Greater care is taken in the preparation of the material, and also in its selection. The enameled brick obtain their enamel in the firing, from one coating; and this enamel can be applied on either unburned or burned brick. The best results are claimed for enamels fused onto the burned brick.

With the glazed brick, the unburnt bricks are coated with a slip—a mixture of the consistency of thick cream—composed of ball clay, flint, feldspar, and kaolin. This mixture is prepared with infinite care by grindings and puddlings. The brick are covered with the slip on one face, and on one end or one face only. The slip gives the face of the brick the color required. It is necessary that the slip and the body of the brick shall have equal shrinkages under fire action. Over the slip, a thin glaze is applied, which, on fusion, unites with the slip and gives it a transparent, glossy, protective covering.

Most of the brick classed as “enam-

eled," are really glazed brick, as the latter present fewer difficulties and involve less cost in manufacture. The kilns in which these brick are fired resemble pottery kilns, in which the direct flame does not come in contact with the enamels or glazes on the brick. The brick are made in many colors from white to dark green or chocolate, and in bright or dull finish.

Enamelled or glazed brick are made in two general sizes: English size, enameled surface 9x3 in., bed 4½ in.; American size, enameled surface, 8¾x2¼ in., bed 4⅛ in.

Salt-glazed brick are made of any clay that vitrifies. The glaze is given to the brick by throwing salt into the fires in the finishing stages of the burning. Several saltings are necessary.

ROOFING TILE

The brick house is at its best when surmounted by a clay tile roof. Roofing tile claim almost as great antiquity as brick, and are found in abundance in oriental ruins. They are imperish-



Fig. 21. Attractive Treatment in Enameled Brick and Tile.

able. Their weight insures them from being shaken loose by strong winds, as is often the case with shingles and slate. Their fire-tested body diminishes the fire hazard from adjacent conflagrations. They are impervious to moisture. They can be procured in different colors to harmonize with the wall color scheme, and these colors

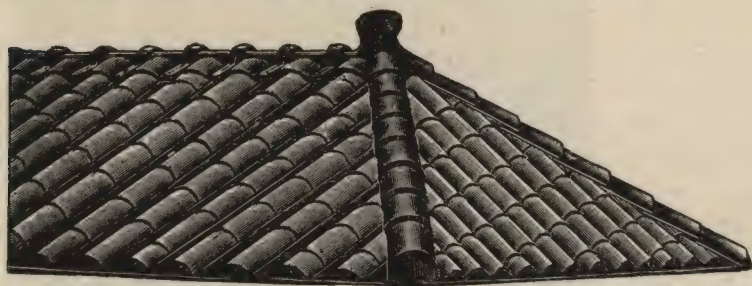


FIG. 20. EFFECTIVE TREATMENT OF RAILROAD DEPOT WITH PAVING-BLOCK WALLS AND ROOF OF CLAY ROOFING TILE.

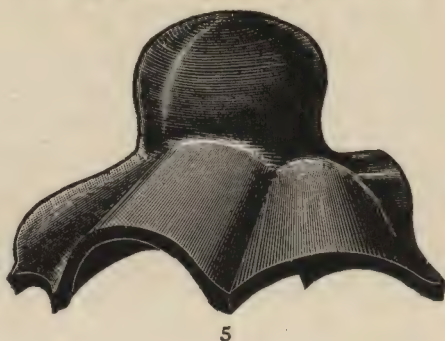
mellow to greater attractiveness with the passage of years.

In their manufacture, the process resembles that of face brick, the presses

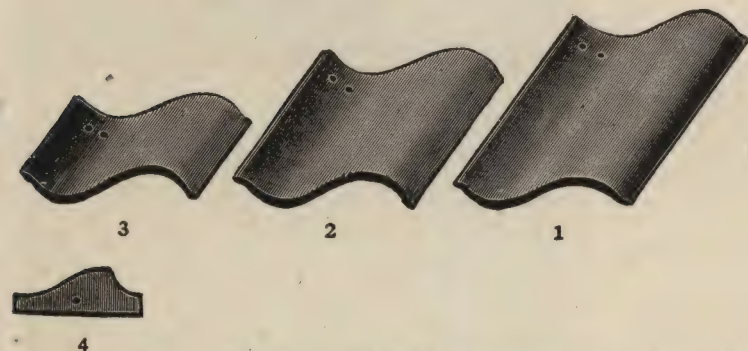
in America have been equipped to make brick in this way, and the product finds a ready sale. Sand-lime brick are very uniform in shape and texture, as there



COMBINATION OF PATENT AMERICAN "S" TILE.

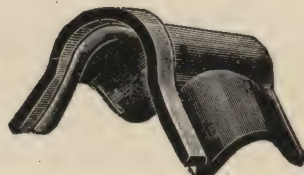


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AMERICAN "S" EAVE CLOSURE.

FIG. 22. THE TILE ROOF, AN EAVE CLOSURE, AND CRESTINGS.



6

AMERICAN "S" CRESTING.

being specially constructed to produce the various shapes, some of which are herewith illustrated. Great care has to be taken also in the setting and the burning so as to prevent warping.

SAND-LIME BRICK

Sand-Lime Brick. About the year 1880, some German experimenters discovered the fact that brick made of sand and lime could be hardened in a few hours by heat and the pressure of steam. At that time they had no vessels of sufficient size and strength to withstand the required pressure, and the patents were allowed to expire before the process became a commercial success.

Within the last ten years many plants

in America have been equipped to make brick in this way, and the product finds a ready sale. Sand-lime brick are very uniform in shape and texture, as there

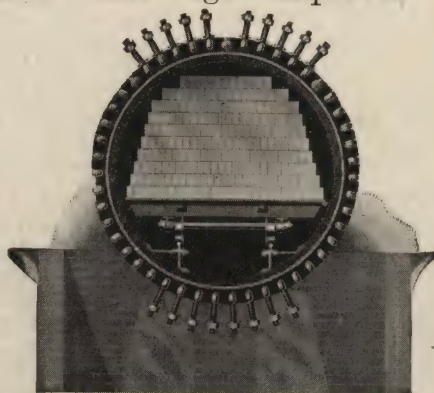


Fig. 23. A Sand-Lime Hardening Cylinder. Section showing car of brick on track inside.

being specially constructed to produce the various shapes, some of which are herewith illustrated. Great care has to be taken also in the setting and the burning so as to prevent warping.

strength and hardness, and that they are strong enough for any ordinary work. The makers are constantly improving their product.

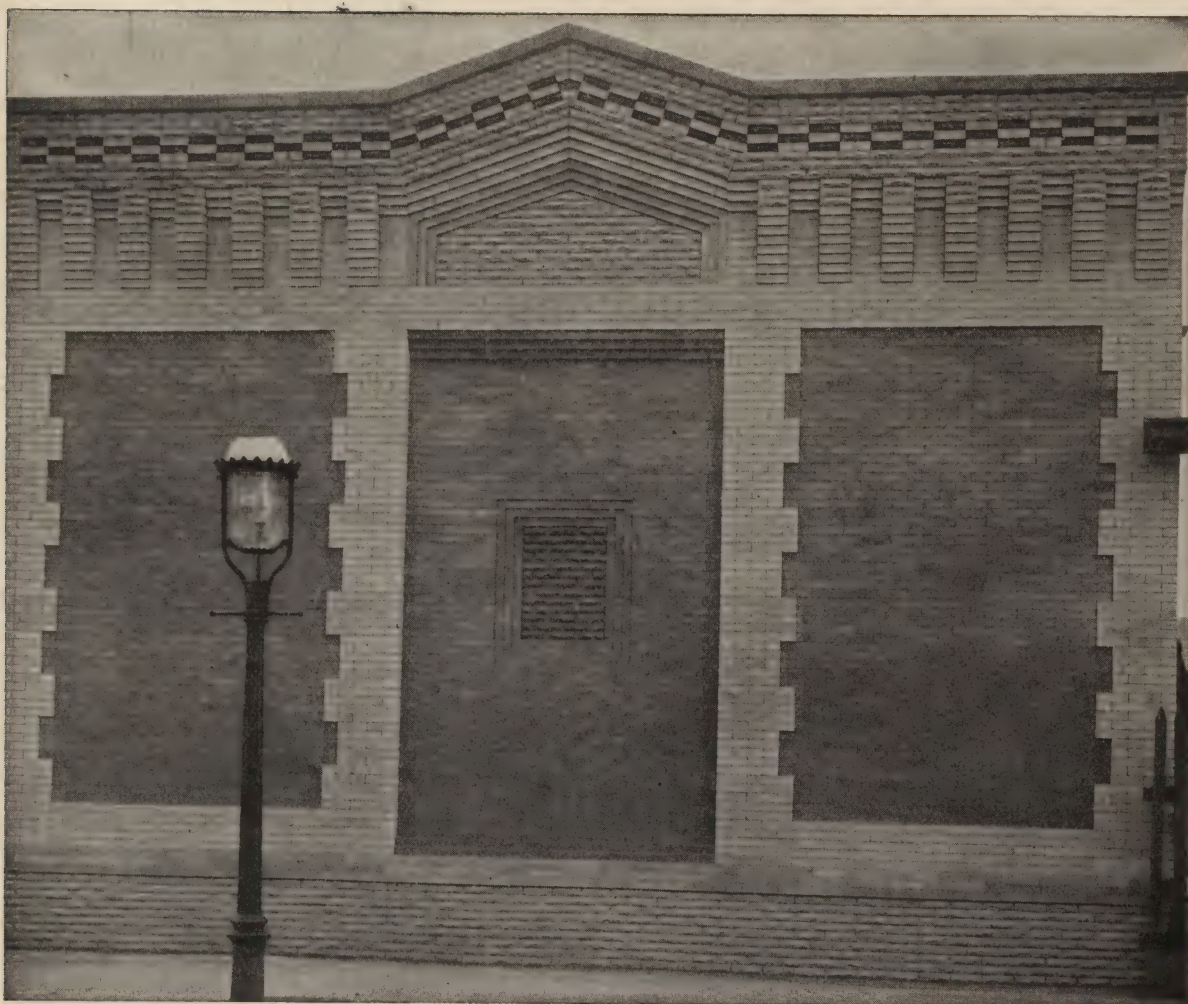


FIG. 24. ORNAMENTAL TREATMENT OF FRONT OF LUMBER DRIER AT HORNELL, N. Y.

Panels of dark blue sand-lime brick; balance plain and rock-faced sand-lime brick in natural color, with good sample of fancy brick laying at top.

Sand-lime brick, as known on the market to-day, are made from a mixture of sand and lime, varying in proportions from 85 to 94 parts of sand to from 15 to 6 parts of lime, according to the respective characters of the limes and sands used. The nature of the lime is probably the most important factor. The successful manufacture of the product depends largely on the perfect mixing of the two materials. The majority of sand-lime brick are made on presses similar to the dry-press machinery used for clay brick, but of ex-

ceptionally heavy construction, the strain on the machinery being so much greater. Rotary presses of German design are also used successfully.

The brick, when molded, are loaded onto cars holding about 1,000, and run into huge cylinders of steel from 45 to 70 ft. long and about 6 ft. in diameter. When the cylinder track is filled with cars, the cylinder-head is bolted, and steam is introduced. The brick are subjected to a pressure approximating 125 lbs. for from 9 to 12 hours. During this time, under the influence of the heat

and moisture, most of the lime unites with the sand, and forms a hydrosilicate of lime.

Sand-lime brick are made to conform to the sizes of clay brick, especially dry-press brick. A brick measuring $8\frac{1}{4}$ by 4 by $2\frac{1}{4}$ in. weighs 5 lbs. When submitted to the absorption test, well-made brick will show from 4 to 10 per cent. The average crushing strength is from 2,500 to 3,000 lbs. per sq. in. Tests on special kinds of sand-lime brick have shown a crushing strength of over 6,000 lbs. per sq. in.

Sand-lime brick are naturally white or gray in color. Manufacturers are, however, placing on the market red, buff, chocolate brown, and pink brick. The colors used are similar to those employed in coloring cement products.

There are about 75 sand-lime brick plants in successful operation in the United States. Their number is steadily increasing, and the product is being standardized.

Table I gives data regarding the strength, absorption, etc., of sand-lime brick.

TABLE I
Sand-Lime Brick

MODULUS OF RUPTURE, LBS. PER SQ. IN.	COMPRESSIVE STRENGTH LBS. PER SQ. IN.	ABSORPTION PER CENT
509	4,344	10.81
766	6,123	8.97
420	2,412	12.70
607	2,244	13.13
555	3,340	9.40
635		8.70

Each of the numbers in the table is the mean of several tests. The sequence of the numbers is of no significance; that is, the numbers in the first line are there by chance.

The modulus of rupture was obtained by breaking the brick, placed on edge

between supports six inches apart, the load being in the middle.

The compression pieces were half-bricks, imbedded on both sides in plaster of Paris.

The absorption test was made by heating the bricks to dry them out, and then keeping them in water for 48 hours. Upon being taken from the water, they were wiped dry and then weighed; and the increase in weight was divided by the weight of the dry brick, and the result multiplied by 100.

It would seem, by comparison with the results of tests given in Tables III and IV, that the results for sand-lime brick are about what would apply to rather soft or salmon brick as regards strength, while the rate of absorption is somewhat less for the sand-lime brick. On many accounts such brick are esteemed by many as being superior to clay brick of equal strength, as they are of finer appearance, and they may be used for the facing of interior walls such as hallways, corridors, vestibules, etc.

CLASSIFICATION OF BRICK

Bricks are classified (1) according to the manner of moulding; (2) according to the place they occupy in the kiln during burning; and (3) according to their shape or the use to which they are to be put.

(1) When distinguished according to the manner of moulding, bricks are named:

Soft-mud brick, made of very wet mud;

Stiff-mud brick, made of mud with less water;

Dry-pressed brick, made of clay containing 4 to 6 per cent of moisture;

Re-pressed brick, made by re-forming partially dried brick made of soft mud,

or brick made of stiff mud; mostly applied to the stiff-mud product.

(2) In the old-style kilns the bricks were not all burned alike. Those adjacent to the fire were over-done; those farthest away from the fire were under-done; and only the intermediate portion were satisfactory. This condition led to the adoption of the names:

Arch-brick, or those forming the top of the firing-place of the kiln.

Soft or salmon brick, or those named from the lack of color or hardness;

Body brick, or those taken from the middle of the kiln.

Mercantile brick are brick well burned, but not graded as to color or degree of hardness.

Hard kiln-run brick are meant to be all suitable for outside work.

In the kilns of modern design, the heat is well distributed throughout the whole mass, and the above terms are not now so appropriate as formerly.

(3) The form and the use for which the brick are intended make the following terms suitable:

Face brick, or those of best appearance as to uniformity of color and dimension, and thus suitable for outside walls. The term is especially used to designate pressed or re-pressed brick.

Ornamental brick are nearly always made by the dry-press process; and this is the name given to all brick differing from the standard shape.

Compass brick, or those having one edge shorter than the other. They are used in building curves on which the length of the brick is a part of the circumference.

Feather-edge brick, or **Voussoir brick**, those similar to compass brick, but having one edge thinner than the

other. They, also, are used in building arches.

Paving brick, or **vitrified blocks**, usually larger than ordinary bricks, used in paving streets.

Sidewalk brick are extra hard-burned brick from good clay, or small paving brick.

Sewer brick, or common brick of better grades, so regular in form as to be suitable for building sewers. They must also be low in absorption.

Sizes and Weight of Brick. The sizes of clay brick are bound to vary, owing to the nature of the material from which they are made. Hard-burned brick shrink more than soft-burned brick during their burning; the quality or the character of the clay in the bank will vary through the season, during its horizontal or vertical working; also the wear of molds and dies during the season will tend to vary the brick-size. The leading brickmakers of the country have established a standard of sizes to which they endeavor to conform their products. (See Table II.)

TABLE II
Standard Sizes of Bricks

Building brick, $8\frac{1}{4} \times 4 \times 2\frac{1}{4}$ in.
Pressed brick, $8\frac{3}{8} \times 4 \times 2\frac{3}{8}$ in.
Paving brick, $8\frac{1}{2} \times 4 \times 2\frac{1}{2}$ in.
Roman brick, $12 \times 4 \times 1\frac{1}{2}$ in.
Norman brick, $12 \times 4 \times 2\frac{3}{8}$ in.
Paving block, $9 \times 4 \times 3$ in.

In actual practice, common brick in the Eastern States average $7\frac{3}{4}$ by $3\frac{3}{4}$ by $2\frac{1}{4}$ in.; and in the Western States, the average is $8\frac{1}{2}$ by $4\frac{1}{8}$ by $2\frac{1}{2}$ in.

In the same kiln, there will be a variation, due to shrinkage, of from $\frac{1}{8}$ to $\frac{1}{2}$ in. between the hard-burned and the soft-burned brick.

The weight of bricks varies according to their size and the kind of clay from which they are made. Common bricks average from $4\frac{1}{2}$ to 5 lbs each. Pressed

TABLE III
Compression Tests of Brick

DIMENSIONS (INCHES)			ULTIMATE LOAD POUNDS	COMPRESSION STRENGTH POUNDS PER SQUARE INCH
WIDTH	LENGTH	DEPTH		
3.85	8.25	2.35	223,000	7,030
3.95	8.25	2.40	259,000	8,020
3.92	8.30	2.37	348,000	10,700
4.00	8.32	2.35	365,000	11,000
3.95	8.25	2.30	462,000	14,150
3.90	8.20	2.30	453,000	14,150
.....				
4.07	8.40	2.55	83,200	2,430
4.05	8.35	2.40	92,800	2,750
4.00	8.00	2.40	125,900	3,930
4.00	8.25	2.40	134,300	4,070
4.00	8.00	2.30	181,500	5,670
3.75	7.60	2.45	238,900	8,390

NOTE—All bricks were imbedded in plaster of Paris before being tested.

bricks weigh from 5 to 5½ lbs. Paving bricks measuring 8 by 4 by 2½ in. weigh 7 lbs. Re-pressed pavers 8½ by 4 by 2½ in. weigh 7½ lbs. Paving blocks 8½ by 4 by 3½ in. weigh approximately 9½ lbs. each.

Bricks weigh from 100 pounds to 150 pounds per cubic foot, according to density. Common bricks weigh about 125 pounds per cubic foot.

Specifications for Good Brick. The following specifications for brick are intended as general rather than specific:

(a) A good brick should possess plane faces, parallel sides, and well-defined edges and corners. In sharpness of outline, dry-pressed brick excel. Following in order of merit in this regard, are re-pressed brick, stiff-mud brick, and soft-mud brick.

(b) A good brick should be uniform in its structure, and should be free from cracks, checks, pebbles, and nodules of lime.

(c) A good brick should give a clear ringing sound when struck with another brick or with a trowel or hammer. Such a brick is strong enough and durable

enough for all ordinary building construction. By “strong enough” we refer to its general strength-distribution, not crushing strength only. Crushing strength in brick is valuable only in comparing different brands. Any well-burned brick will have compressive strength far beyond any strain to which it may be ordinarily submitted in wall-compression. The strength of brick masonry depends more on the quality of its mortar bond than the compressive strength of its brick units. Most cities demand a crushing strength of from 2,000 to 2,500 lbs. per sq. in. The range of averages of hundreds of tests is from 2,700 to 5,000 lbs. per sq. in. In a wall the transverse strength is usually of more importance than the crushing strength.

(d) A brick should not absorb more than one-tenth of its weight of water. It seems to be well established that brick with high absorption are most readily affected by the action of water and frost. As a rule, hard-burned brick absorb the least water, and brick absorbing little water are more durable in walls and foundations. Under-burned soft brick, used for back-

ing will absorb from 20 to 30 per cent of water, while brick of high quality will not absorb more than 4 or 5 per cent. A brick absorbing only one-tenth of its weight of water may be called "good."

(e) The compressive strength of good-quality brick should be not less than 2,500 pounds per square inch for building brick, and 4,000 pounds per square inch for piers and heavy work.

(f) The modulus of rupture of brick should be not less than 750 pounds per square inch.

Tests of Brick. Tables III and IV show the results of some recent tests of shale building brick made in central Illinois. The higher results are from selected hard-burned brick; and the

TABLE IV
Transverse Tests of Brick

DIMENSIONS (IN.)		TOTAL CENTER LOAD, LBS.	MODULUS OF RUP- TURE, LBS. PER Sq. IN.
DEPTH	WIDTH		
3.97	2.38	4,100	963
3.96	2.38	4,900	1,180
3.85	2.37	5,700	1,450
3.86	2.39	6,100	1,540
3.95	2.48	8,000	1,860
3.90	2.40	8,000	1,970
3.94	2.44	7,600	1,800
4.05	2.45	1,300	292
4.08	2.48	1,900	413
4.05	2.40	2,100	480
4.02	2.40	2,100	489
4.00	2.40	2,000	516
4.00	2.45	2,800	643

NOTE—The bricks were tested on edge with a span of 6 inches. The load was applied at the middle of the span, and across the upper surface of the brick.

lower, from samples which were soft and under-burned.



DICTIONARY OF TERMS

- Bat**—A part of a brick.
- Batter**—A term used to signify the slope of a wall upward and away from the observer. When the slope is toward him, it is designated **overhang**.
- Bed**—In bricklaying, the horizontal surfaces in which the bricks of the walls lie in courses.
- Belt**—A course of brick projecting from a brick wall, generally in line with the sills of the windows. It may be either molded or plain.
- Bond-Timbers**—Timbers embedded horizontally in the walls of brick buildings in tiers, to which laths, battens, etc., are attached.
- Breaking Joint**—The arrangement of bricks so as not to allow two joints to come immediately over each other.
- Bond**—The arrangement of brick in wall to secure the best combination of strength and good appearance.
- Efflorescence**—The formation of a white scum or powder on the surface of brickwork.
- Encaustic**—Refers to the fixing of colors on tile, porcelain, glass, or brick by burning; hence encaustic tile, encaustic brick, etc.
- Flue**—The passage in a chimney through which the smoke and gases make their exit. Each passage is a flue; all the exits in combination comprise the chimney.
- Herringbone**—The diagonal arrangement of brick in a wall or pavement.
- Headers**—Brick laid across the thickness of the wall.
- Heading Course**—A course entirely composed of headers.
- Stretchers**—Brick laid lengthwise in the wall.
- Terra-Cotta**—Burned clay of fine quality molded into architectural ornaments, pillars, vases, etc., and capable of coloration to duplicate any form of stone work; also molded into fireproofing hollow tile.
- Trimmer Arch**—An arch built in front of a fireplace, and supporting the hearth.
- Withes**—The partition between two chimney-flues in the same stack or chimney.
- Tuck-Pointing**—Consists in filling up the raked-out joints of old brickwork with cement or hard-setting mortar.
- Course**—Name given to one row of bricks in any thickness of wall between two bed-joints.
- Cross-Joints**—Short, vertical joints at right angles to and connecting the bed-joints. Also called **perpends**.
- Transverse Joints**—Cross-joints continued through the thickness of the wall.
- Lap**—The horizontal distance between the crossjoints in two successive courses.
- Closers (King and Queen)**—A king closer is a brick of normal width for half its length, and reduced to half its width in the remaining half, making a closer. A queen closer is a brick cut to half its width throughout its length. The same effect is often produced by using two half-lengths.
- Toothing**—When a brick wall is to be continued at some future time, it is toothed by leaving each header projecting $2\frac{1}{4}$ in. beyond the stretching courses above and below so that the new work can be bonded to it.
- Racking**—Where part of the wall is delayed while the rest is carried up, the edges of the work being done are racked back $2\frac{1}{4}$ in. at each course, to reduce possibility of defects through unequal settlement of the new work.
- Scutch**—A stock and blade used for cutting hard brick.
- Club Hammer and Bolster**—Used for cutting brick with greater exactitude than can be done by the trowel. The bolster is a kind of broad chisel.

THE BRICKLAYER'S KIT

The tools shown in Fig. 1 are those generally used by the bricklayer and his helper. They may be enumerated as follows:

Tools for Preliminary and Finishing Work—

Pick for breaking up hard ground; grafting tool for digging out hard-pan or like stiff clay; shovel; chalk line; truing rod, for taking levels; spirit level; hod, for mortar and brick; hose, for mixing mortar, often termed larry; mall or beetle, a large wooden mallet, with head 18 x 15 in. and a handle 3 ft. long; rammers, for paving work; tampers, for trench work.

Tools for Bricklaying—

Trowel, large, for spreading mortar and bedding brick; 2-foot rule; 3-foot straight-edge with courses marked on it; plumb rule and bob; spirit-level;

line and pins, for maintaining straight work between corners.

Tools for Brick Cutting—

For rough cutting, a large trowel, club hammer, and bolster and cold chisel are employed.

For fair cutting with hard bricks, a tin saw, chopping block, and scutch; with soft bricks there are used a wire saw, a rubbing stone, a mold-box, square, bevel, and compasses.

Tools for Pointing—

Small trowel, a feather-edged straight-edge, a joint trimmer, and a jointer for tuck-pointing in old work.

With bricklayers' tools, as with any others, the best tools are the cheapest in the long run.

Brick Construction

Brick structures are made by imbedding the brick in mortar made of lime or cement and sand. The mortar is used for two purposes: it serves to cement the bricks together so that they act as a unit, and it also acts as a cushion to distribute the pressure.

If ordinary mortar of lime and sand be used, that will be the weakest part of the brick wall, and the joints should be kept thin, not over $\frac{1}{4}$ inch in good work. If Portland cement mortar be used, it may be as strong as the brick, but in this case economy usually prompts the builder to make thin joints.

Laying the Brick. Brick are usually quite porous, and, if laid dry, will extract much of the water from the mortar. The effect of this is to weaken the mortar; and so the practice is to wet the brick before they are laid. It is common practice to specify that the brick are to be laid with a **shove joint**. This means that the mortar is to be spread on first, then the brick is laid lightly in it, and shoved diagonally back from the face and up against the adjacent brick. This manner of laying forces the mortar into the irregularities of the brick, and increases the adhesion between the two substances.

Bond. By this term in brickwork is meant the arrangement of the brick so that each one tends to transfer vertical pressure to two or more below in such a way that no single tier of brick acts alone. By bonding, all parts of the wall are tied together by the weight imposed on the bricks; and an effective distribution of a concentrated weight is thus made over an ever-increasing area. This is accomplished by means of

headers and stretchers, as in stone masonry. It is generally accepted that a perfect bond in brickwork can be secured where two headers plus one mortar joint equal one stretcher.

The two styles of bond in most common use are the English and the Flemish bond.

English Bond. This manner of laying is shown in Fig. 25, where all the bricks

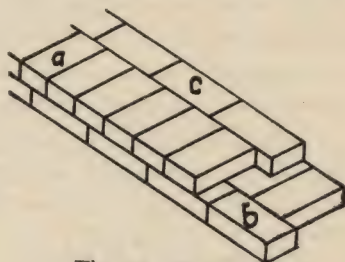
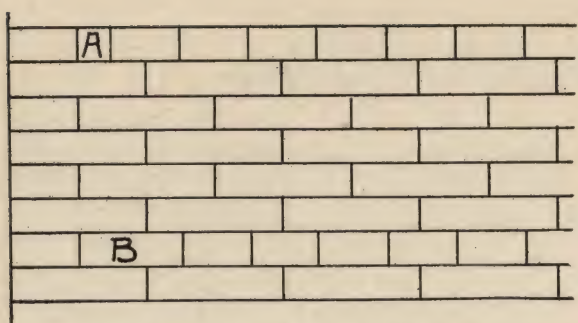
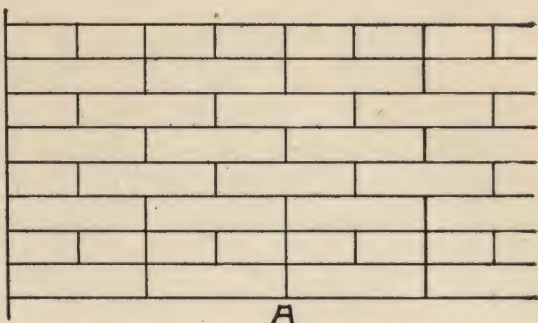


Fig. 25. English Bond.

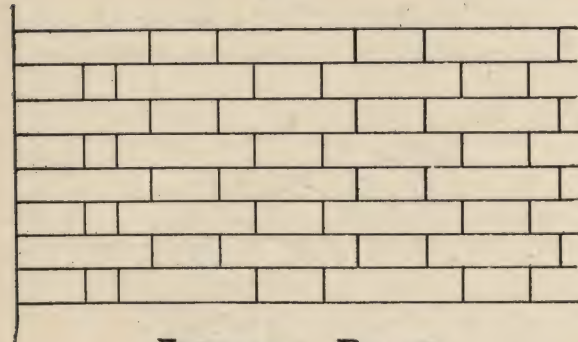
in the face of the course **a** are **headers**. In the face of the course below, all are **stretchers**. It is usual to have one row of headers to every half-dozen rows or so of stretchers, although the true bond of this type has them in alternate layers. This method is really known as the **common bond**, but has taken the name "English bond" because of its similarity of header and stretcher arrangement. The common bond effects considerable economy, as the true English bond is wasteful of face brick without showing a definitely needed gain of strength. With alternating courses of headers and stretchers, one-half the face of the wall will be headers—a decided waste of face-brick value. The arrangement of the bricks in the back, as at **c**, depends upon the thickness of the wall. A piece of brick of less than full section in the face or in the interior of the wall, used to fill in where a whole



COMMON BOND
(1)



BOND STARTED WRONG
(2)



FLEMISH BOND
(3)



ENGLISH BOND
(4)

FIG. 26. VARIOUS BONDS IN BRICKWORK.

1—Header course run at intervals as at *A* and *B*; 2—Vertical joints superimposed as at *A* should be avoided; 3—Every alternate course has headers of full brick; 4—Every alternate course a header course, and every sixth course should be of full headers.

brick would be too large, is called a **bat**. As it is not always possible to build a wall of entire bricks, bats are used to make the face appearance uniform. The joints in the header courses must be made thinner than the others to

definite pattern in the joints by disposing of the vertical joints in a way which has a pleasing effect to the eye.

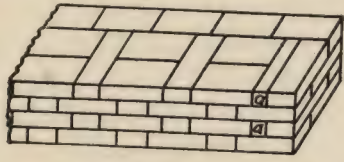


Fig. 27. Flemish Bond.

preserve the proper spacing, since there are more of them.

Flemish Bond. This bond makes a very strong wall, and the face presents a particularly pleasing effect. The bond is formed by alternate headers and stretchers in each course, and forms a

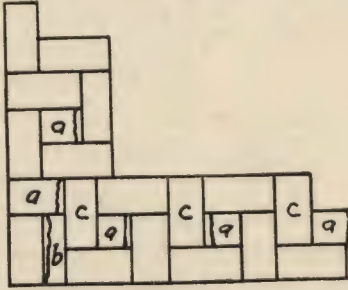


Fig. 28. Plan of Corner Built with Flemish Bond.

This bond is considered more difficult and costs more to lay than the "English," but it is in common use. Figs. 27 and 28 show a wall laid up in this manner. Here, again, the thickness of the wall and the frequency of the corners

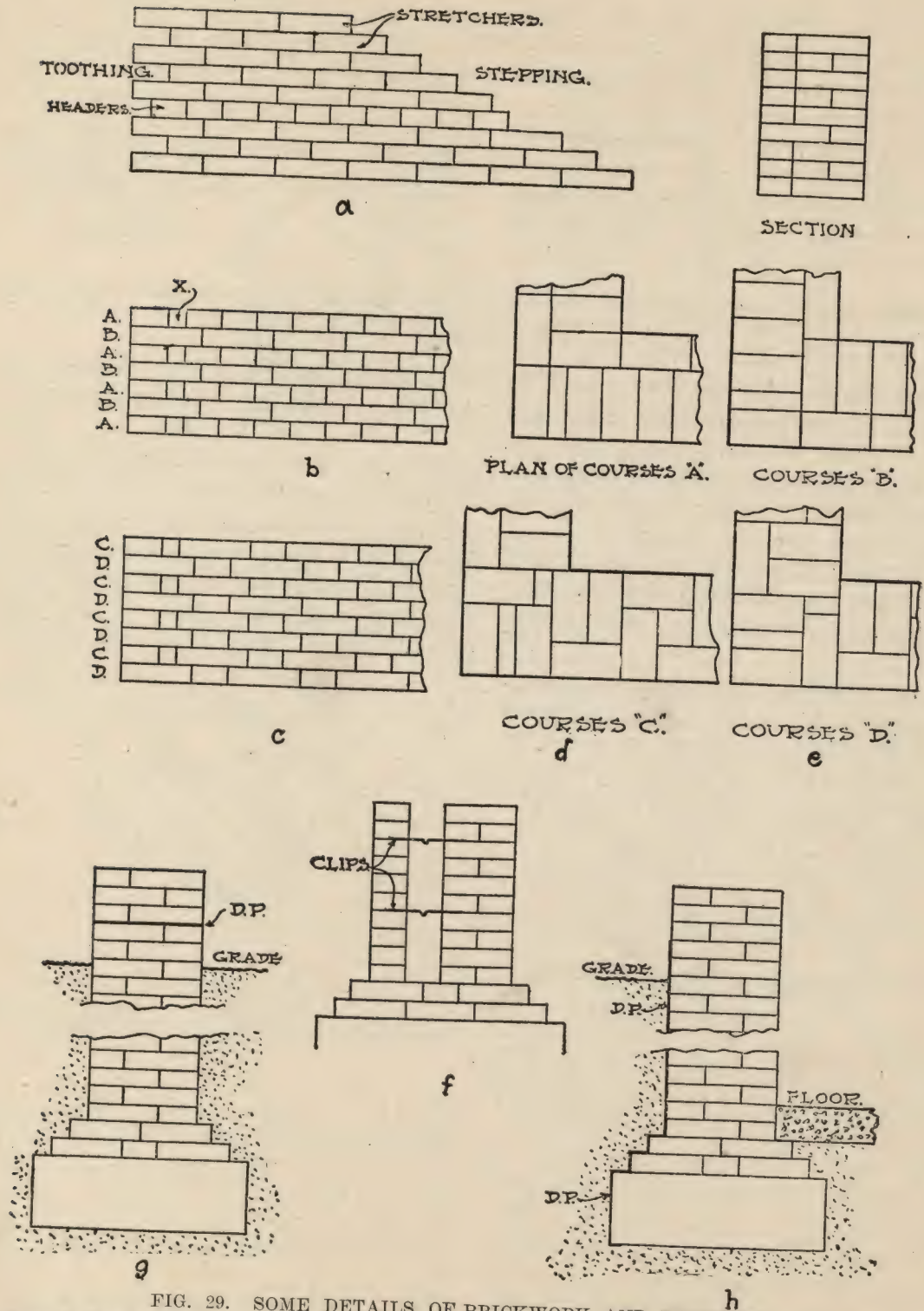
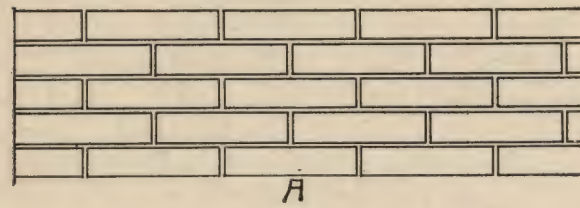


FIG. 29. SOME DETAILS OF BRICKWORK AND BONDING.

Fig. a shows the bond used in ordinary brickwork, with headers every sixth course. Fig. b, English bond. Fig. c, Flemish bond. Figs. d and e, plan views of English and Flemish bonds. Fig. f, construction of hollow brick wall. Fig. g, damp-proof course in brick wall where there is no basement. Fig. h, damp-proof course protecting brick wall and foundation to make a dry basement. In extra wet locations, the damp-proof course is carried under footings and floor.

determine the arrangement of the bats to make the face regular. Occasionally both sides of the wall are faces on which



face brick are laid as stretchers, with the joints plumb above each other from bottom to top of wall (see Fig. 30). The

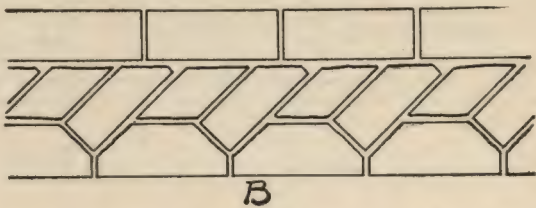


Fig. 30. Plumb, Diagonal, or American Bond, Used Generally for Facing Walls with Pressed Brick. All Face-Brick are Stretchers with Joints Plumb over One Another (A); Bond Made by Clipping Back Corners of Face-Brick Every Sixth or Seventh Course, and Laying Diagonal Headers Behind (B).

the appearance must be that of alternate headers and stretchers. Many apparent headers are only bats, even in walls of good workmanship; and the real headers are not necessarily of full cross-section.

When part of the bricks are darker than others, the dark ones are frequently selected as headers, with pleasing results.

A corner built with Flemish bond to look alike in front and back, is shown in Fig. 28. Bats are shown at points a. The brick b is split to secure the proper spacing in both front and back. The

bonding of the face to the common brick is made by clipping off the back corners of the face bricks about every sixth course, laying diagonal headers behind. It is not a good method of bonding, but answers certain requirements under special conditions, such as might be imposed by an endeavor to save waste of face-brick headers, and by difficulty arising from face brick and common

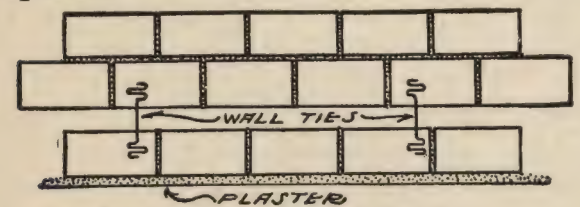


Fig. 31. Brick Wall With Air-Space. Horizontal section of hollow brick wall, 8 in. outside and 4 in. inside, with a 2-in. air-space, bonded with metal wall-ties every fifth course of brick. Since no moisture can penetrate through such a wall across this air-space, the plaster can be applied directly to the inside face of the wall without the use of furring.

course above that shown is built to break joints with this one. The face of the wall is like that in Fig. 27. This is a 13-inch wall, in which the narrow brick is shown at a.

Plumb bond, American bond, or Diagonal bond is generally used when the walls are faced with pressed brick. The

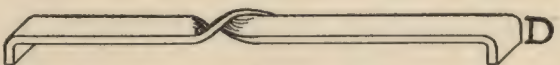
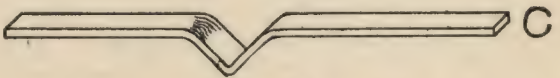
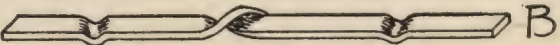
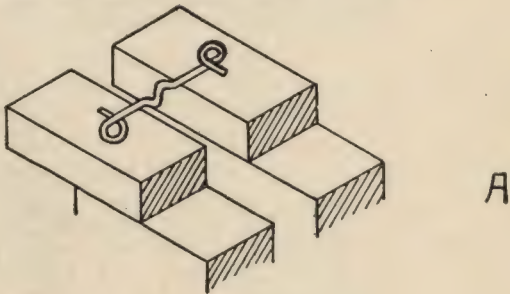


Fig. 32. Metal Ties for Bonding Brick Hollow Walls. A—Morse galvanized steel wire tie in use; B, C, D—Unpatented forms of ties that can be made by any blacksmith.

brick not coming out to exactly the same heights. This last difficulty—which is by no means uncommon—is offered a solution by means of galvanized steel-wire wall-ties, as shown in Fig. 31. By means of these ties, made in lengths of from 7 to 16 in., differences between the

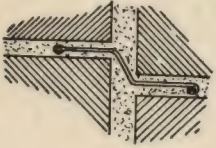


Fig. 33. Metal Tie for Face-Brick and Backing.

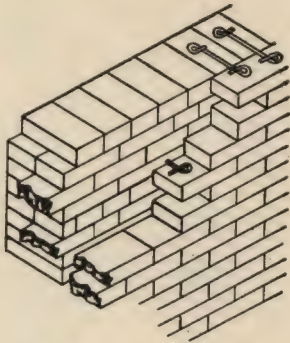
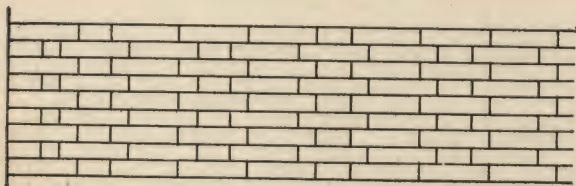
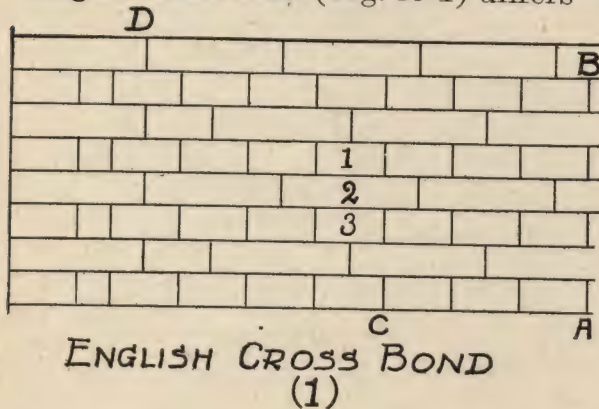


Fig. 34. Use of Morse Tie for Bonding Face-Brick to Backing.

levels of the face and backing courses are made negligible, as the ties can be bent to conform to any existing difference. When these ties are used, good practice calls for bonding every fourth course with one tie to each face-brick.

English cross bond (Fig. 35-1) differs



from the regular English bond only by the stretchers of the successive courses breaking joint with each other as well as with the headers in adjoining wall-courses. A supposed St. George's cross effect in the wall-pattern gave the bond its name. The bond is more attractive than the regular English type.

Pieces of hoop-iron laid flat in the bed-joints of brickwork, are used to give longitudinal strength and to prevent cracks through uneven settlement. This practice is known as **Hoop-iron bond**.

A method of bonding a veneer of brickwork to a wooden building by means of iron wire hooks, is shown in Fig. 38.

Bonding Brickwork in Angles. Various methods of bonding brick walls under different conditions, are shown in Figs. 41-46. The titles and the illustrations are sufficiently explanatory to obviate the necessity of extended description.

Bonding New to Old Brickwork. In making additions to or special altera-

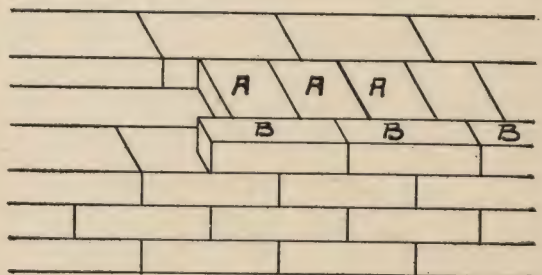
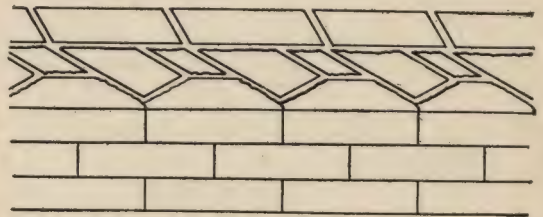


FIG. 35. VARIOUS BONDS IN BRICKWORK.

- 1—Each alternate stretcher course breaks joint with the stretcher course below, dividing face of wall into St. George's crosses, as shown at 1, 2, 3; 2—Clipped or diagonal secrete bond, used where it is not desired to show headers in facework; 3—Garden or boundary wall bond, country bond, or Scotch bond; built with 3 stretchers and one header constantly recurring in each course; 4—Stretcher course clipped to half-width, and a $\frac{3}{4}$ bond course laid behind.

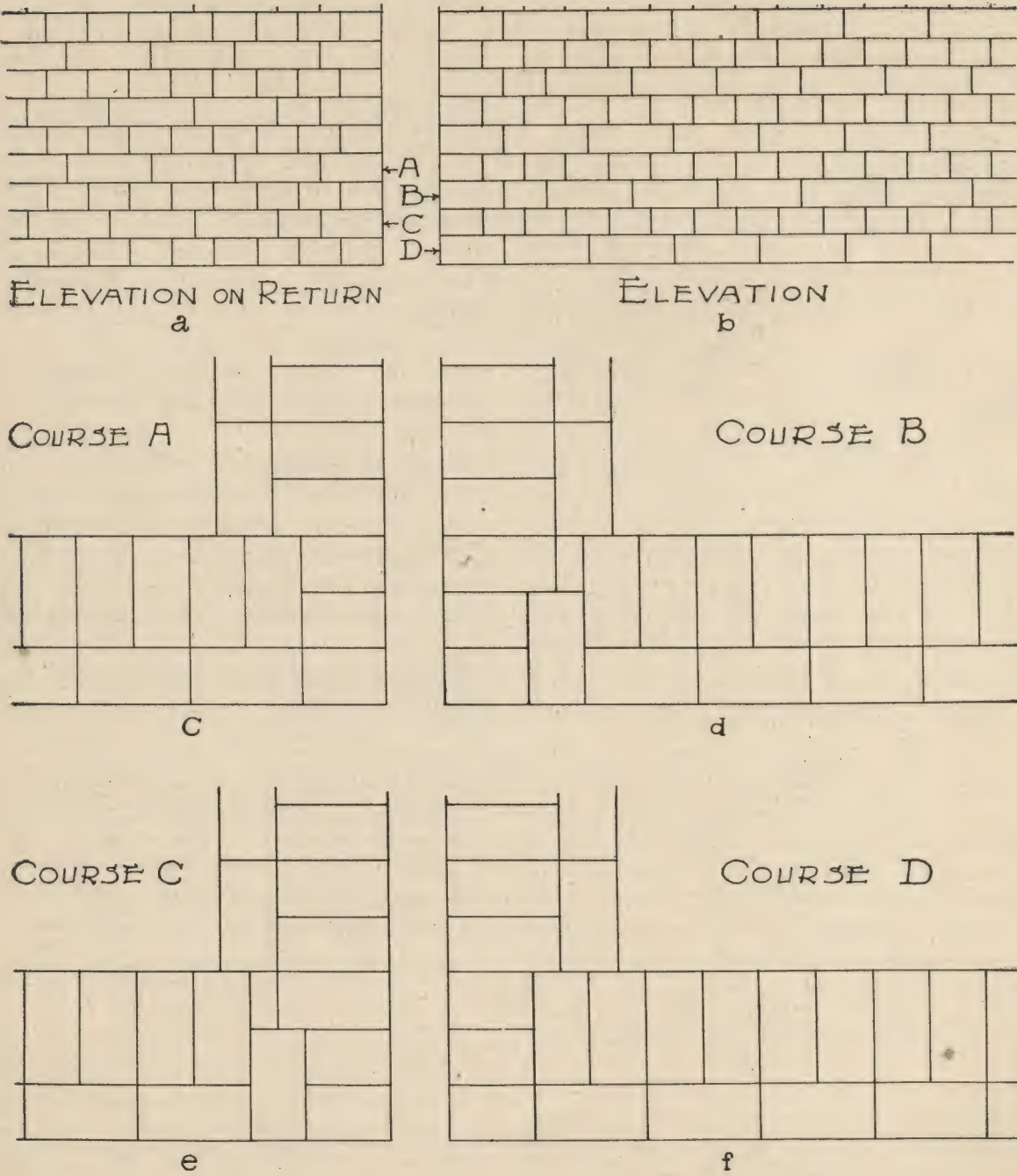


FIG. 36. ELEVATIONS AND PLANS OF VARIOUS COURSES IN DUTCH BOND BRICKWORK.

In every alternate stretcher course, a header is used as the second brick from the quoin; in the other stretcher courses, $\frac{3}{4}$ bricks are used at the quoins; and in the header courses, the use of closers is dispensed with.

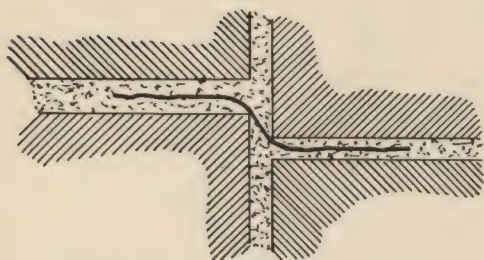
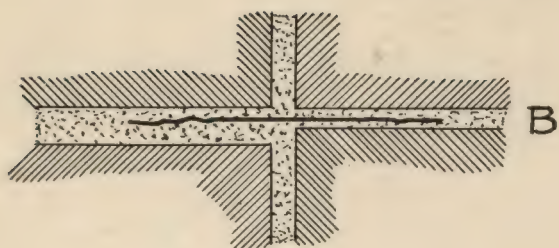


Fig. 37. Use of Metal Wall-Ties.
A—Method giving poor bond; B—Proper Method, ties used at courses where face-brick and backing come to same level.

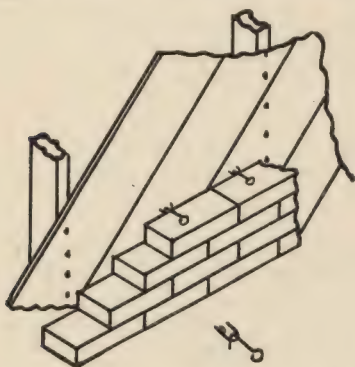


Fig. 38. Method of Bonding Brickwork Veneer to a Wooden Building.

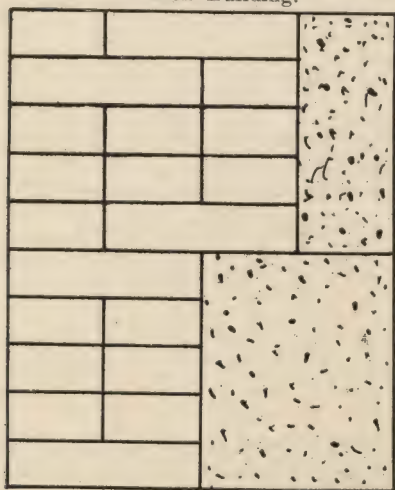


Fig. 39. Backing Ashlar.

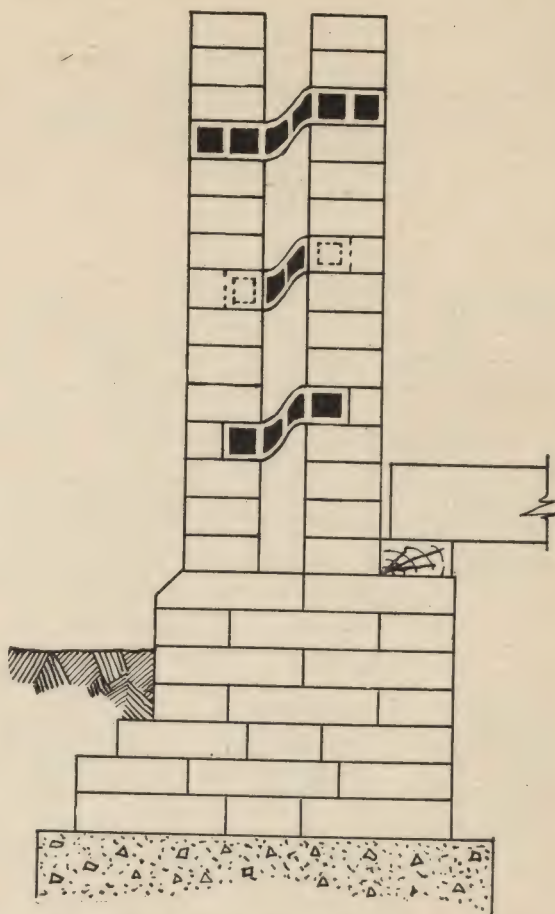


Fig. 40. Use of Special Tie or Bonding Brick to Tie Two Portions of Hollow Wall Together.

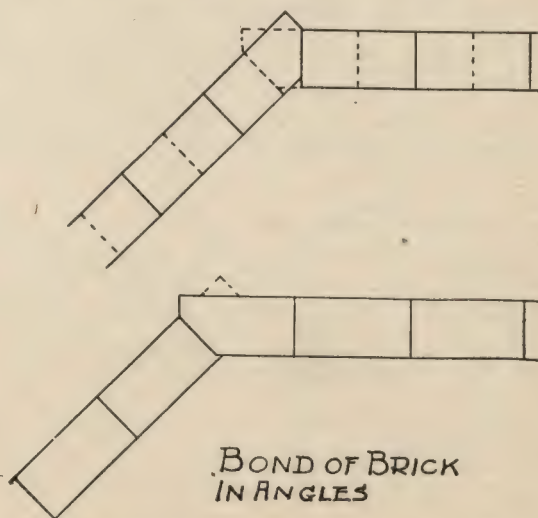


Fig. 41. Method of Running Up an Octagon Corner with Ordinary Brick.
Dotted lines in upper diagram show position of next course below as indicated by lower diagram.

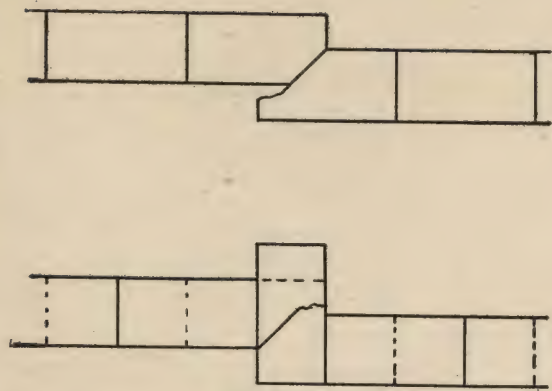


Fig. 42. Method of Bonding at a Break of Less Than 4 Inches in a Brick Wall.
Upper diagram shows one course; lower, the next course, with previous course indicated by dotted lines.

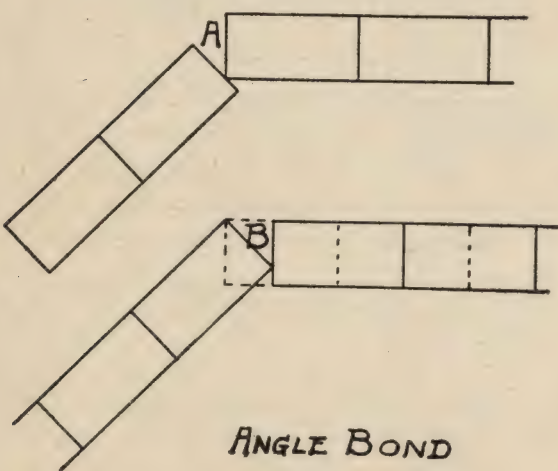


Fig. 43. Another Method of Carrying Up an Angle with Common Brick.
A shows one course; B, the next course above, recesses or "pigeon-holes" being left at the angle as indicated.

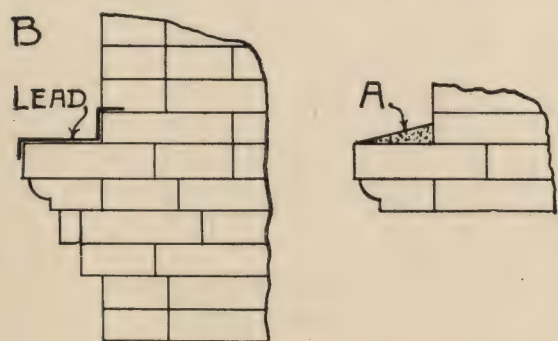


Fig. 44. Covering Projecting Courses.
A—Cement mortar used; B—Use of lead, a better method.

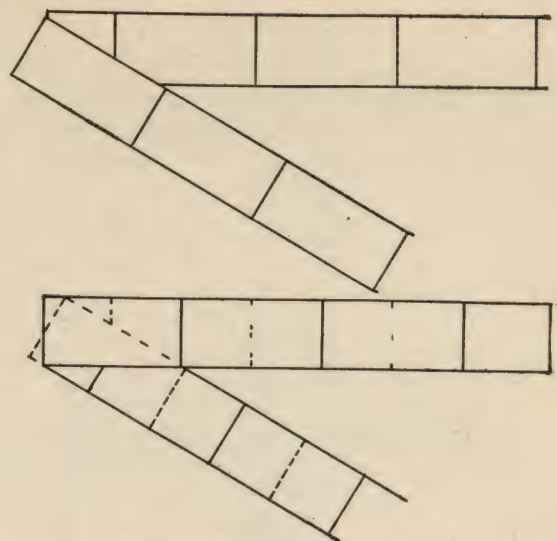


Fig. 45. Bond in Sharp Angle.
Alternate courses shown by the two diagrams; dotted lines indicate the course below.

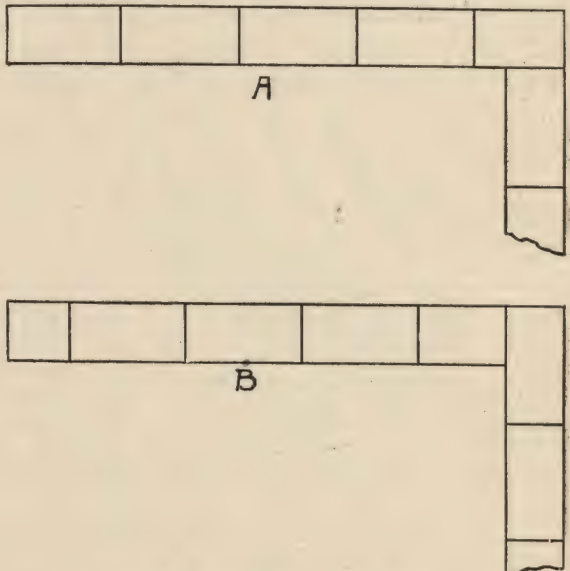


Fig. 46. Running Bond in Angles.
A—One course; B—Next course above. Bats or clipped brick, if there are any, should be used at the corner.



Fig. 47. Raking Bond, Used in Thick Walls at Intervals of 4 to 8 Courses, to Remedy Weakness Due to Lack of Interior Stretchers.

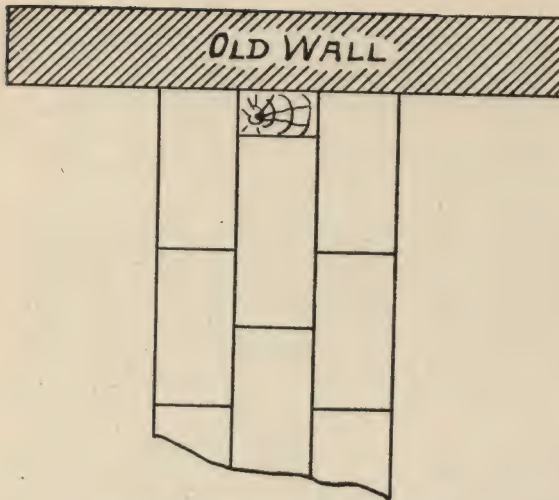


Fig. 48. Bonding New to Old Work.
Stud 2x4-in. spiked to old wall, and new work built around it.

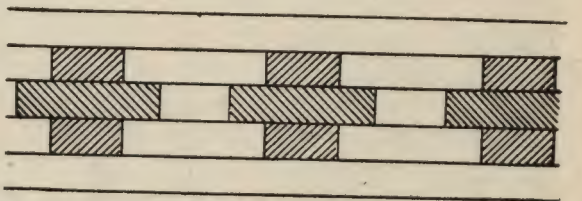
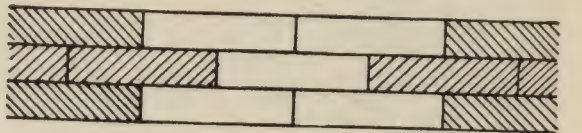
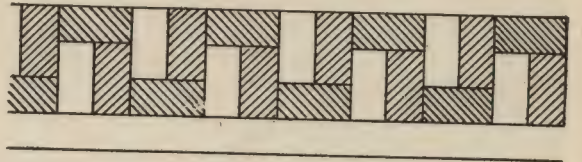
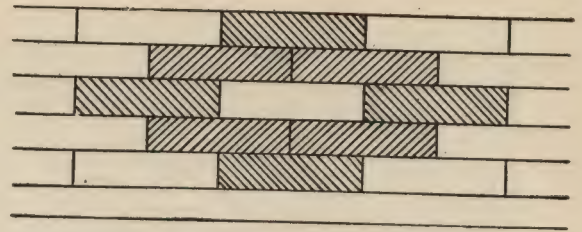


Fig. 50. Ornamental Panel and Frieze Designs in Brick of Two Colors.

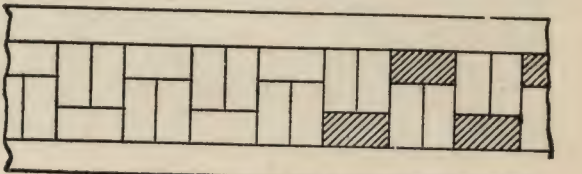


Fig. 51. Ornamental Panel Design in Common Brick. Two-color effect secured by sinking bricks $\frac{1}{2}$ in. from face of wall, as shown by the shaded bricks.

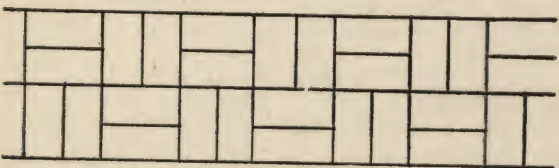
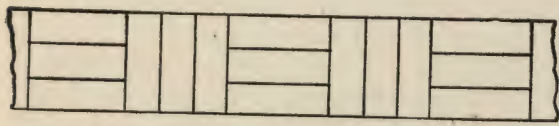
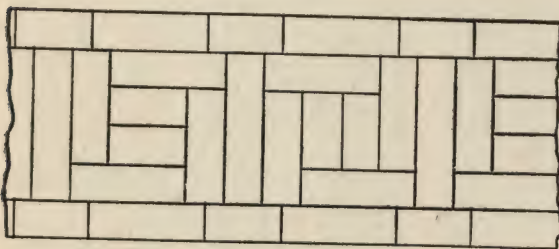


Fig. 49. Panel and Frieze Designs in Common Brick All of One Color.

Design depends wholly on the joints.

tions in buildings, where a new brick wall adjoins an old wall, it is advisable to anchor them together. This can be done either by taking out some of the old brickwork and inserting the iron anchors in the spaces thus provided, or

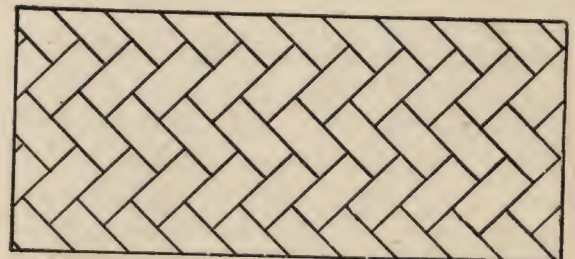


Fig. 52. Herringbone Work.

a 2 by 4-in. studding can be spiked to the old wall, and the new wall can be built around it, as shown in Fig. 48.

Ornamental Effects Produced with Plain Brick. In Figs. 49-52, an interesting study is presented of some of the many designs that can be produced with ordinary brick for panels, friezes, borders, etc. The shaded brick repre-

table for receiving water. Its advocates claim it shows a smoother wall.

The joint at **B**, known as a **weather joint**, is the opposite of **A**. It is more difficult of accomplishment, but sheds falling water. It is opposed because,



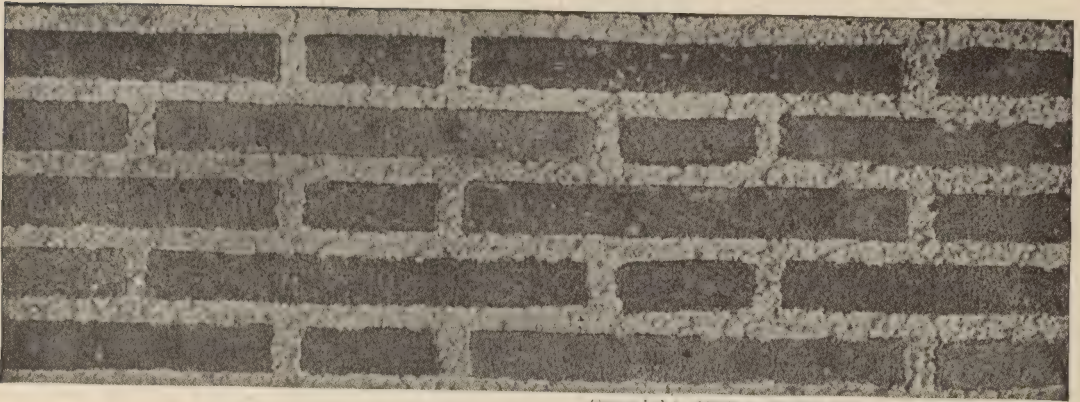
FIG. 53. ATTRACTIVE RESIDENCE OF COLONIAL TYPE IN MEMPHIS, TENNESSEE. Built of white-brick laid in yellow mortar; red tile roof. Cost, \$22,000. Home of Mr. J. N. Falls. Architects, L. M. Weathers Co.

sent the contrasts obtained by the use of two colors of brick.

Pointing for Brickwork. In Fig. 55, the different styles of pointing brickwork are shown. The **struck joint** shown at **A** is the most common. It is made with the point of the trowel, which rests on the lower course of brick and is guided by the top course as it is drawn along. It would seem that this is a joint born of operative necessity, as it is the easiest one to make from the inside of the wall. It is often objected to because it offers a

in looking up the wall, the observer can see the projections of the under side of the brick shown by the in-strike. As to appearance, choice between **A** and **B** is a matter of taste to be decided by those who favor smooth- or rough-appearing wall surfaces. **B** is undoubtedly the most weather-proof.

The joint shown at **C** is much used in pressed-brick work; and that at **D** is its obverse. These and the other special joints are made with special jointing tools of the desired shape, with the exception of that shown at **E**. To



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FIG. 54. SHOWING EFFECT OBTAINED BY USE OF WIDE MORTAR JOINTS. Brickwork in Blair House, Oyster Bay, L. I. "A reproduction . . . of those used in the famous Baths of Titus."

make this, an iron rod is used the thickness of the joint. This is laid on the face edge of the brick already placed, and the mortar is spread out to it. When the mortar has set enough, the rod is removed. Several rods are required.

If mortar is not spread properly, a poor joint will result as shown in Fig. 56 (a and b).

A poor joint is often to be noted in the laying of face brick with "butter" joints. The required thinness of the joint cannot be secured by a full spread of mortar, and the mortar is deposited as shown in Fig. 56 (c), with the result shown in Fig. 56 (d), where the center is unprotected and there is a risk of spalling under pressure as indicated by the ragged line.

Flat or Flush Joints. These are formed by pressing with the trowel the wet mortar that protrudes beyond the face, making the joint flat and flush with the wall. A joint of this type may be varied by making a semicircular groove through the central length of the joint, by means of a jointing tool and straight-edge. It is then known as a flat joint jointed.

Strength of Brick Masonry. The strength of brick is some indication of the strength of the masonry made from it, but the mortar and the workmanship must also be taken into account in making comparisons.

Table V gives results of some recent tests of brick columns made of brick

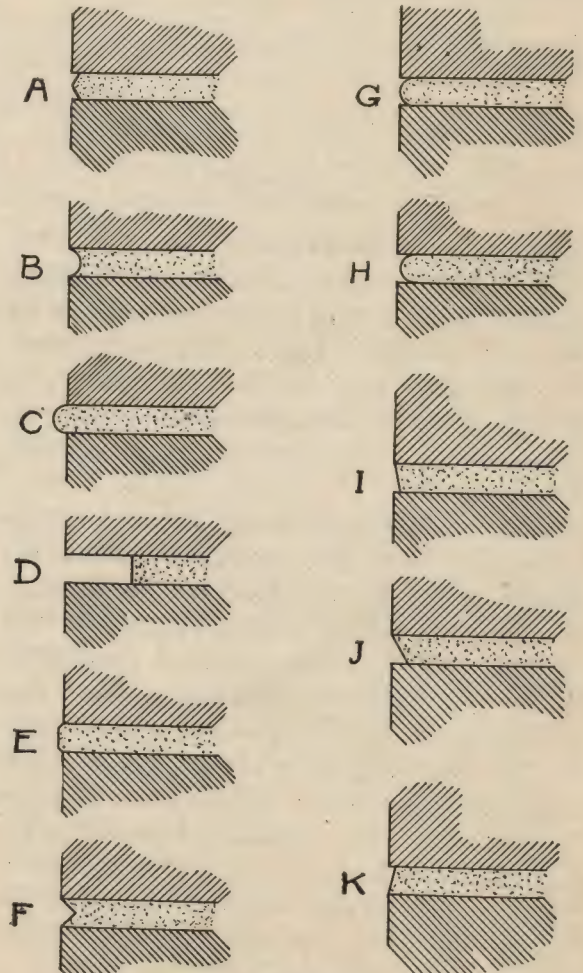


Fig. 55. Styles of Pointing for Brickwork.

TABLE V
Summary of Tests of Brick Columns
Average Values

REFERENCE	CHARACTERISTICS OF COLUMNS	AVERAGE UNIT- LOAD (LBS. PER Sq. IN.)	RATIO OF STRENGTH OF COLUMN TO STRENGTH OF BRICK	CRUSHING STRENGTH OF 6-IN. MORTAR CUBES (LBS. PER Sq. IN.)	RATIO OF STRENGTH OF COLUMN TO STRENGTH OF CUBES
SHALE BUILDING BRICK					
A	Well laid, 1:3 Portland cement mortar 67 days	3,365	.31	*2,870	1.17
B	Well laid, 1:3 Portland cement mortar 6 months	3,950	.37	.....	.....
C	Well laid, 1:3 Portland cement mortar, ec- centrically loaded, 68 days	2,800	.26	.....	.....
D	Poorly laid, 1:3 Portland cement mortar, 67 days	2,920	.27	*2,870	1.05
E	Well laid, 1:5 Portland cement mortar, 65 days	2,225	.21	1,710	1.30
F	Well laid, 1:3 Natural cement mortar, 67 days	1,750	.16	305	5.75
G	Well laid, 1:2 Lime mortar, 66 days.....	1,450	.14	.....	.....
UNBURNED CLAY BRICK					
H	Well laid, 1:3 Portland cement mortar, 63 days	1,060	.27	*2,870	.37

*Average value based on 13 tests of 1:3 Portland cement mortar cubes 60 days old.

similar to those referred to in Tables III and IV. The columns were 12½ inches square, and were from 40 to 43 courses of brick high. The letters at the left refer to groups of several tests. Group **H** is of under-burned clay brick. The load in **C** was applied one inch from the center.

The results shown in Table V indicate that both the strength of the individual bricks and that of the mortar are factors in the strength of the columns. As it is the weakest part that fails, it is evident economy to have the strength of the various parts the same.

The building laws of the city of Chicago provide that "brickwork in walls laid in standard Portland cement mortar shall not be loaded more than 25,000 pounds per square foot. Brickwork in an ordinary cement mortar shall not be loaded more than 18,000 pounds per

square foot. Brickwork in walls laid in lime mortar shall not be loaded more than 13,000 pounds per square foot."

When we consider the results of tests as shown in Table V, it is thus seen that a large factor of safety is allowed in practice.

Brickwork Laid in Freezing Weather.

When it is necessary to lay bricks in freezing weather, there are several ways to counteract the effect of the cold. It should not, however, be assumed that any of the suggested plans are entirely satisfactory. The brick and sand may be heated before being laid; the space to be occupied by the wall may be enclosed within a temporary structure; or the freezing point of the mortar may be lowered by the addition of salt to the water. This last method should be used only when the brick themselves have been warmed so as to remove ice

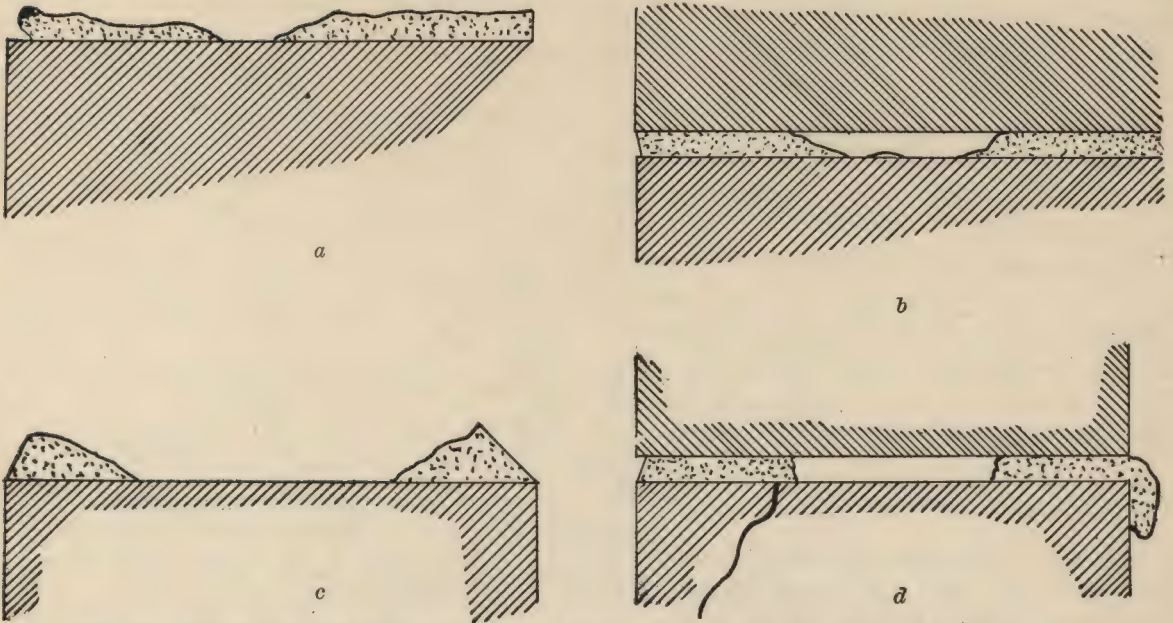


FIG. 56. SHOWING WHAT TO AVOID IN SPREADING MORTAR FOR LAYING BRICK.
a—Cavity made by blunt trowel under center of brick; *b*—Poor joint; open space under entire length of brick;
c—Same defect in spreading mortar for “butter” joint; *d*—Result of spreading mortar as in *c*; because of
 lack of full mortar bed, undue pressure causes brick to spall as shown.

and frost from the surface. If this is not done, there will not be firm adhesion between the mortar and the brick.

The rule for mixing mortar for winter use is this: Dissolve one pound of salt in 18 gallons of water for working in a temperature at freezing point; and for lower temperatures, use one ounce of salt additional for each degree that the temperature is below freezing. Enough salt must be used to prevent the mortar from freezing, whatever the temperature may be.

MEASUREMENT OF BRICKWORK

It is customary to estimate brickwork by the thousand brick contained in the wall. As many parts are not open to inspection, it is clearly not possible to determine the number by actual count, and recourse must be had to measurement.

The work of building around openings is not nearly so difficult with brick as with stone; and accordingly not so

great an allowance for openings need be made in the case of brickwork as in the case of stone masonry.

The actual number of bricks in a cubic foot varies with the thickness of the mortar joints as well as with the size of the brick; but usually the average is between $17\frac{1}{2}$ and $19\frac{1}{2}$. An average of 18 may be taken as very nearly suitable in most cases when the work is continuous, and the joints $\frac{1}{4}$ inch thick. When there are many openings and small piers, requiring much cutting and consequent waste, it is safe to allow 20 brick per cubic foot for the work.

When asking for bids on work, it is well to specify just how the measurement of the quantity shall be made; and the following rule is to be recommended as fair and tending to prevent controversy:

Divide the total number of superficial feet of wall surface of a given thickness by 160, and multiply the result by the

number of brick widths the wall is thick. The result will be the number of thousand of brick contained.

This rule is based on the fact that a 4-inch wall contains about 1,000 brick to 160 superficial feet, if the joints be $\frac{1}{4}$ inch thick.

For example, a 12-inch wall 40 feet long and 20 feet high would contain $40 \times 20 \div 160 \times 3 = 15$ thousand bricks.

While the above rule gives the number of brick to be purchased for the wall, another abitrary rule for the payment of the masons is sometimes adopted:

Count $7\frac{1}{2}$ bricks for each superficial foot of wall for each half-brick (half-length of brick) thickness of wall.

In the same example as above, this would give $40 \times 20 \times 7\frac{1}{2} \times 3 = 18$ thousand bricks as a basis of payment for the labor.

The **allowance for openings** is not a uniform practice, but may be fairly well established by custom in any given city. These customs must be consulted in letting or computing such work.

When no deduction is made for openings, it is not customary to make extra payment for arches, buttresses, pilasters, and the like.

Amount of Material Required. In estimating the cost of a proposed piece of brickwork, the rule given above determines the number of thousand of brick required. The amount of sand, lime, or cement depends on the richness of the mortar and the thickness of the joints.

Table VI gives the necessary amount of sand and cement to lay 1,000 bricks with joints about $\frac{3}{8}$ inch thick.

Stated otherwise, a cubic yard of brick masonry with $\frac{1}{2}$ -inch joints requires rather more than 1-3 of a cubic

TABLE VI
Mixing Table for Mortar for Laying 1,000 Bricks

MORTAR	LIME BARRELS	CEMENT BARRELS	SAND Cu. Yds.
Lime	1	.....	.....
Sand .....	.....	.....	0.5
Portland Cement .....	.....	1.5	.....
Sand .....	.....	.....	0.5
Natural Cement .....	.....	1.5	.....
Sand .....	.....	.....	0.5
Portland Cement	1	.....	.....
Lime .....	.....	1	.....
Sand .....	.....	.....	0.5

yard of mortar. If the joints are $\frac{1}{4}$ inch thick, $\frac{1}{4}$ cubic yard of mortar will be sufficient to lay a cubic yard of brickwork. When joints are only $\frac{1}{8}$ inch thick, $\frac{1}{8}$ cubic yard of mortar will be required to a cubic yard of brickwork.

A barrel of lime will make $2\frac{1}{4}$ barrels (or 3 cubic yards) of lime paste. A barrel of this paste, with 3 barrels of sand, will make 3 barrels of lime mortar. A barrel of unslaked lime is sufficient for $6\frac{3}{4}$ barrels of 1 to 3 mortar.

Data Concerning Brickwork. The weight of brick walls, at 112 pounds per cubic foot, is:

9-inch wall, 84 pounds per superficial foot.

13-inch wall, 121 pounds per superficial foot.

18-inch wall, 168 pounds per superficial foot.

22-inch wall, 205 pounds per superficial foot.

26-inch wall, 243 pounds per superficial foot.

A load of sand or mortar is a cubic yard.

Sand weighs from 80 to 115 pounds per cubic foot, or 1 to $1\frac{1}{2}$ tons per cubic yard.

A cubic yard of mortar requires a

cubic yard of sand, and equals 30 hodfuls.

A bricklayer's hod holds 20 bricks.

Masonry with $\frac{3}{8}$ -inch joints contains 500 bricks per cubic yard. With $\frac{1}{8}$ -inch joints, the number will be 575.

No 8-inch brick wall should be over 14 feet in height.

A mason and his helper should lay 1,000 bricks in seven hours on plain work.

The waste of brick in good material is about 2 per cent for ordinary work; in soft or salmon, as much as 5 per cent.

Walls that are a brick-length thick are often called 9-inch walls.

A 13-inch wall is a brick-length, plus its width, plus the thickness of a mortar joint.

A 17-inch wall has a thickness equal to the length of two bricks, with the mortar joint.

A barrel of Portland cement, nominally 400 pounds, weighs about 380 pounds net.

A barrel of natural cement, nominally 300 pounds, weighs about 265 pounds net.

A barrel of lime weighs about 200 pounds.

Two and a half bushels equals a barrel.

BRICK BUILDING PRACTICE

As an example of what is considered to be safe and conservative practice in the construction of piers, walls, and partitions of brickwork, the following sections are reproduced from the New York Building Code of 1901. While building codes of other cities may vary somewhat in detail from the following, the main points are very similar, as may be seen from a glance at Table VIII, concerning required thicknesses of building walls in various cities.

NEW YORK BUILDING CODE

Sec. 27. **Materials of Walls.** The walls of all buildings other than frame or wood buildings, shall be constructed of stone, brick, Portland cement concrete, iron, steel, or other hard, incombustible material; and the several component parts of such buildings shall be as herein provided. All buildings shall be inclosed on all sides with independent or party walls.

Sec. 28. **Walls and Piers.** In all walls of the thickness specified in this code, the same amount of materials may be used in piers or buttresses. Bearing walls shall be taken to mean those walls on which the beams, girders, or trusses rest. If any horizontal section

through any part of any bearing wall in any building shows more than 30 per cent area of flues and openings, the said wall shall be increased 4 inches in thickness for every 15 per cent, or fraction thereof, of flue or opening area in excess of 30 per cent.

The walls and piers of all buildings shall be properly and solidly bonded together with close joints filled with mortar. They shall be built to a line, and be carried up plumb and straight. The walls of each story shall be built up the full thickness to the top of the beams above. All brick laid in non-freezing weather shall be well wet before being laid. Walls or piers, or parts of walls and piers, shall not be built in freezing weather; and, if frozen, shall not be built upon.

All piers shall be built of stone or good, hard, well-burnt brick, laid in cement mortar. Every pier built of brick, containing less than 9 superficial feet at the base, supporting any beam, girder, arch, or column on which a wall rests, or lintel spanning an opening over 10 feet and supporting a wall, shall at intervals of not over 30 inches apart in height have built into it a bond-stone not less than 4 inches thick, or a cast-iron plate of sufficient strength and the full size of the piers. For piers fronting on a street, the bond-stones may conform

with the kind of stone used for the trimmings of the front. Cap-stones of cut granite or bluestone, proportioned to the weight to be carried, but not less than 5 inches in thickness, by the full size of the pier, or cast-iron plates of equal strength, by the full size of the pier, shall be set under all columns or girders, except where a 4-inch bond-stone is placed immediately below said cap-stone, in which case the cap-stone may be reduced in horizontal dimensions at the discretion of the Commissioner of Buildings having jurisdiction. Isolated brick piers shall not exceed in height ten times their least dimensions. Stone posts for the support of posts or columns above shall not be used in the interior of any building. Where walls or piers are built of coursed stones, with dressed level beds and vertical joints, the Department of Buildings shall have the right to allow such walls or piers to be built of a less thickness than specified for brickwork, but in no case shall said walls or piers be less than three-quarters of the thickness provided for brickwork.

In all brick walls every sixth course shall be a heading course, except where walls are faced with brick in running bond, in which latter case every sixth course shall be bonded into the backing by cutting the course of the face brick and putting in diagonal headers behind the same, or by splitting the face brick in half and backing the same with a continuous row of headers. Where face brick is used of different thickness from the brick used for backing, the courses of the exterior and interior brickwork shall be brought to a level bed at intervals of not more than ten courses in height of the face brick; and the face brick shall be properly tied to the backing by a heading course of the face brick. All bearing walls faced with brick laid in running bond shall be 4 inches thicker than the walls are required to be under any section of this Code.

Sec. 29. Ashlar. Stone used for the facing of any building, and known as "ashlar," shall be not less than 4 inches thick.

Stone ashlar shall be anchored to the backing; and the backing shall be of such thickness as to make the walls, independent of the ashlar, conform as to the thickness with the

requirements of sections 31 and 32 of this Code, unless the ashlar be at least 8 inches thick and bonded into the backing, and then it may be counted as part of the thickness of the wall.

Iron ashlar plates used in imitation of stone ashlar on the face of a wall, shall be backed up with the same thickness of brickwork as stone ashlar.

Sec. 30. Mortar for Walls and Ashlar. All foundation walls, isolated piers, parapet walls, and chimneys above roofs shall be laid in cement mortar; but this shall not prohibit the use in cold weather of a small proportion of lime to prevent the mortar from freezing. All other walls built of brick or stone shall be laid in lime, cement, or lime and cement mortar mixed.

The backing up of all stone ashlar shall be laid up with cement mortar, or cement and lime mortar mixed; but the back of the ashlar may be pargeted (plastered over) with lime mortar to prevent discoloration of the stone.

Sec. 31. Walls for Dwelling-Houses. The expression "walls for dwelling-houses" shall be taken to mean and include in this class walls for the following buildings:

Dwellings, asylums, apartment houses, convents, club-houses, dormitories, hospitals, hotels, lodging-houses, tenements, parish buildings, schools, laboratories, studios.

The walls above the basement of dwelling-houses not over three stories and basement in height, nor more than 40 feet in height, and not over 20 feet in width, and not over 55 feet in depth, shall have side and party walls not less than 8 inches thick, and front and rear walls not less than 12 inches thick. All walls of dwellings exceeding 20 feet in width, and not exceeding 40 feet in height, shall be not less than 12 inches thick. All walls of dwellings 26 feet or less in width between bearing walls which are hereafter erected or which may be altered to be used for dwellings, and being over 40 feet in height and not over 50 feet in height, shall be not less than 12 inches thick above the foundation wall. No wall shall be built having a 12-inch-thick portion measuring vertically more than 50 feet. If over 50 feet in height and not over 60 feet in height, the wall shall be not less than 16 inches thick in the story next

above the foundation walls; and from thence not less than 12 inches to the top. If over 60 feet in height, and not over 75 feet in height, the walls shall be not less than 16 inches thick above the foundation walls to the height of 25 feet, or to the nearest tier

than 24 inches thick above the foundation walls to the height of 40 feet, or to the nearest tier of beams to that height; thence not less than 20 inches thick to the height of 75 feet, or to the nearest tier of beams to that height: thence not less than 16 inches thick



FIG. 57. AN OLD SAND-LIME BRICK HOUSE.

Built before 1860. Located at 207 Government St., Mobile, Ala. This house was built some time in the sixties by a man named Sadler. The brick were made by hand and air-hardened, the process taking several months. They are not so perfect in form and finish as our modern brick, but the building is still in excellent condition, as shown above.

of beams to that height; and thence not less than 12 inches thick to the top. If over 75 feet in height, and not over 100 feet in height, the walls shall be not less than 20 inches thick above the foundation walls to the height of 40 feet, or to the nearest tier of beams to that height; thence not less than 16 inches thick to the height of 75 feet, or to the nearest tier of beams to that height, and thence not less than 12 inches thick to the top. If over 100 feet in height, and not over 125 feet in height, the walls shall be not less

to the height of 110 feet, or to the nearest tier of beams to that height; and thence not less than 12 inches thick to the top. If over 125 feet in height, and not over 150 feet in height, the walls shall be not less than 28 inches thick above the foundation walls to the height of 30 feet, or to the nearest tier of beams to that height; thence not less than 24 inches thick to the height of 65 feet, or to the nearest tier of beams to that height; thence not less than 20 inches thick to the height of 100 feet, or to the nearest tier of beams to that

height; thence not less than 16 inches thick to the height of 135 feet, or to the nearest tier of beams to that height; and thence not less than 12 inches thick to the top. If over 150 feet in height, each additional 30 feet in height or part thereof, next above the foundation walls, shall be increased 4 inches in thickness, the upper 150 feet of wall remaining the same as specified for a wall of that height.

All non-fireproof dwelling-houses erected under this section, exceeding 26 feet in width, shall have brick fore-and-aft partition walls. All non-bearing walls of buildings hereinbefore in this section specified, may be 4 inches less in thickness, provided, however, that none are less than 12 inches thick, except as in this Code specified. Eight-inch brick partition walls may be built to support the beams in such building in which the distance between the main or bearing walls is not over 33 feet; if the distance between the main or bearing walls is over 33 feet, the brick partition wall shall be not less than 12 inches thick; provided that no clear span is over 26 feet. No wall shall be built having any one thickness measuring vertically more than 50 feet. This section shall not be constructed to prevent the use of iron or steel girders, or iron or steel girders and columns, or piers of masonry, for the support of the walls and ceilings over any room which has a clear span of more than 26 feet between walls, in such dwellings as are not constructed fireproof; nor to prohibit the use of iron or steel girders, or iron or steel girders and columns, in place of brick walls in buildings which are to be used for dwellings when constructed fireproof. If the clear span is to be over 26 feet, then the bearing walls shall be increased 4 inches in thickness for every 12½ feet or part thereof that said span is over 26 feet; or shall have, instead of the increased thickness, such piers or buttresses as, in the judgment of the Commissioner of Buildings having jurisdiction, may be necessary.

Whenever two or more dwelling-houses shall be constructed not over 12 feet 6 inches in width, and not over 50 feet in height, the

alternating center wall between any two such houses shall be of brick not less than 8 inches thick above the foundation wall; and the ends of the floor beams shall be separated that 4 inches of brickwork will be between the beams where they rest on the said center wall.

Sec. 32. **Walls for Warehouses.** The expression "walls for warehouses" shall be taken to mean and include in this class walls for the following buildings:

Warehouses, stores, factories, mills, printing houses, pumping stations, refrigerating houses, slaughter houses, wheelwright shops, cooperage shops, breweries, light and power houses, sugar refineries, office buildings, stables, markets, railroad buildings, jails, police stations, courthouses, observatories, foundries, machine shops, public assembly buildings, armories, churches, theaters, libraries, museums.

The walls of all warehouses 25 feet or less in width between walls or bearings shall be not less than 12 inches thick to the height of 40 feet above the foundation walls. If over 40 feet in height, and not over 60 feet in height, the walls shall be not less than 16 inches thick above the foundation walls to the height of 40 feet, or to the nearest tier of beams to that height; and thence not less than 12 inches thick to the top. If over 60 feet in height, and not over 75 feet in height, the walls shall be not less than 20 inches thick above the foundation walls to the height of 25 feet, or to the nearest tier of beams to that height; and thence not less than 16 inches thick to the top. If over 75 feet in height, and not over 100 feet in height, the walls shall be not less than 24 inches thick above the foundation walls to the height of 40 feet, or to the nearest tier of beams to that height; thence not less than 20 inches thick to the height of 75 feet, or to the nearest tier of beams to that height; and thence not less than 16 inches thick to the top. If over 100 feet in height, and not over 125 feet in height, the walls shall be not less than 28 inches thick above the foundation walls to the height of 40 feet, or to the nearest tier of beams to that height; thence not less than

24 inches thick to the height of 75 feet, or to the nearest tier of beams to that height; thence not less than 20 inches thick to the height of 110 feet, or to the nearest tier of beams to that height; and thence not less than 16 inches thick to the top. If over 125 feet in height, and not over 150 feet, the walls shall be not less than 32 inches thick above the foundation walls to the height of 30 feet, or to the nearest tier of beams to that height; thence not less than 28 inches thick to the height of 65 feet, or to the nearest tier of beams to that height; thence not less than 24 inches thick to the height of 100 feet, or to the nearest tier of beams to that height; thence not less than 20 inches thick to the height of 135 feet, or to the nearest tier of beams to that height; and thence not less than 16 inches thick to the top. If over 150 feet in height, each additional 25 feet in height, or part thereof, next above the foundation walls, shall be increased 4 inches in thickness, the upper 150 feet of wall remaining the same as specified for a wall of that height.

If there is to be a clear span of over 25 feet between the bearing walls, such walls shall be 4 inches more in thickness than in this section specified, for every $12\frac{1}{2}$ feet, or fraction thereof, that said walls are more than 25 feet apart; or shall have, instead of the increased thickness, such piers or buttresses as, in the judgment of the Commissioner of Buildings, may be necessary.

The walls of buildings of a public character shall be not less than in this Code specified for warehouses, with such piers or buttresses, or supplemental columns of iron or steel, as, in the judgment of the Commissioner of Buildings having jurisdiction, may be necessary to make a safe and substantial building.

In all stores, warehouses, and factories over 25 feet in width between walls, there shall be brick partition walls, or girders supported on iron, steel, or wood columns, or piers of masonry.

In all stores, warehouses, or factories, in case iron, steel, or wood girders supported by iron, steel, or wood columns, or piers of

masonry, are used in place of brick partition walls, the building may be 75 feet wide and 210 feet deep, when extending from street to street; or, when otherwise located, may cover an area of not more than 8,000 superficial feet. When a building fronts on three streets it may be 105 feet wide and 210 feet deep; or, if a corner building fronting on two streets, it may cover an area of not more than 12,500 superficial feet; but in no case wider nor deeper, nor to cover a greater area, except in the case of fireproof buildings. An area greater than herein stated may, considering location and purpose, be allowed by the Board of Buildings, when the proposed building does not exceed three stories in height.

Sec. 33. Increased Thicknesses of Walls for Buildings more than 105 Feet in Depth.

All buildings, not excepting dwellings that are over 105 feet in depth, without a cross-wall or proper piers or buttresses, shall have the side or bearing walls increased in thickness 4 inches more than is specified in the respective sections of this Code for the thickness of walls, for every 105 feet, or part thereof that the said buildings are over 105 feet in depth.

Sec. 34. Reduced Thickness for Interior Walls. In case the walls of any building are less than 25 feet apart, and less than 40 feet in depth, or there are cross-walls which intersect the walls, not more than 40 feet distant, or piers or buttresses built into the walls, the interior walls may be reduced in thickness in just proportion to the number of cross-walls, piers, or buttresses, and their nearness to each other; provided, however, that this clause shall not apply to walls below 60 feet in height, and that no such wall shall be less than 12 inches thick at the top, and gradually increased in thickness by set-offs to the bottom. The Commissioner of Buildings having jurisdiction is hereby authorized and empowered to decide (except where herein otherwise provided for) how much the walls herein mentioned may be permitted to be reduced in thickness, according to the peculiar circumstances of each case, without endangering the strength and safety of the building.

Sec. 35. **One-Story Brick Buildings.** One-story structures not exceeding a height of 15 feet may be built with 8-inch walls when the bearing walls are not more than 19 feet apart, and the length of the 8-inch bearing walls does not exceed 55 feet. One-story and basement extensions may be built with 8-inch walls when not over 20 feet wide, 20 feet deep, and 20 feet high to dwellings.

Sec. 36. **Inclosure Walls for Skeleton Structures.** Walls of brick built in between iron or steel columns, and supported wholly or in part on iron or steel girders, shall be not less than 12 inches thick for 75 feet of the uppermost height thereof, or to the nearest tier of beams to that measurement, in any building so constructed; and every lower section of 60 feet, or to the nearest tier of beams to such vertical measurement, or part thereof, shall have a thickness of 4 inches more than is required for the section next above it, down to the tier of beams nearest to the curb level; and thence downward the thickness of walls shall increase in the ratio prescribed in section 26, this Code.

Sec. 37. **Curtain Walls.** Curtain walls built in between piers or iron or steel columns, and not supported on steel or iron girders, shall be not less than 12 inches thick for 60 feet of the uppermost height thereof, or nearest tier of beams to that height, and increased 4 inches for every additional section of 60 feet or nearest tier of beams to that height.

Sec. 38. **Existing Party Walls.** Walls heretofore built for or used as party walls, whose thickness at the time of their erection was in accordance with the requirements of the then existing laws, but which are not in accordance with the requirements of this Code, may be used, if in good condition, for the ordinary uses of party walls, provided the height of the same be not increased.

Sec. 39. **Lining Existing Walls.** In case it is desired to increase the height of existing party or independent walls which are less in thickness than required under this Code, the same shall be done by a lining of brickwork to form a combined thickness with the old wall of not less than 4 inches more than the

thickness required for a new wall corresponding with the total height of the wall when so increased in height. The said linings shall be supported on proper foundations and carried up to such height as the Commissioner of Buildings having jurisdiction may require. No lining shall be less than 8 inches in thickness; and all lining shall be laid up in cement mortar, and thoroughly anchored to the old brick walls with suitable wrought-iron anchors, placed 2 feet apart and properly fastened or driven into the old walls in rows alternating vertically and horizontally with each other, the old walls being first cleaned of plaster or other coatings where any lining is to be built against the same. No rubble wall shall be lined except after inspection and approval by the Department.

Sec. 41. **Walls Tied, Anchored, and Braced.** In no case shall any wall or walls of any building be carried up more than two stories in advance of any other wall, except by permission of the Commissioner of Buildings having jurisdiction; but this prohibition shall not include the inclosure walls for skeleton buildings. The front, rear, side, and party walls shall be properly bonded together, or anchored to each other every 6 feet in their height by wrought-iron tie anchors, not less than $1\frac{1}{2}$ inches by $\frac{3}{8}$ inch in size, and not less than 24 inches in length. The side anchors shall be built into the side or party walls not less than 16 inches, and into the front and rear walls, so as to secure the front and rear walls to the side or party walls when not built and bonded together. All exterior piers shall be anchored to the beams or girders on the level of each tier. The walls and beams of every building, during the erection or alteration thereof, shall be strongly braced from the beams of each story, and, when required, shall also be braced from the outside, until the building is inclosed. The roof tier of wood beams shall be safely anchored, with plank or joist, to the beams of the story below, until the building is inclosed.

Sec. 42. **Arches and Lintels.** Openings for doors and windows in all buildings shall have good and sufficient arches of stone, brick, or

terra-cotta, well built and keyed with good and sufficient abutments or lintels of stone, iron, or steel of sufficient strength, which shall have a bearing, at each end, of not less than 5 inches on the wall. On the inside of all openings in which lintels shall be less than the thickness of the wall to be supported, there shall be timber lintels, which shall rest at each end not more than 3 inches on any wall, which shall be chamfered at each end, and shall have a suitable arch turned over the timber lintel. Or the inside lintel may be of cast iron or wrought iron or steel; and in such case stone blocks or cast-iron plates shall not be required at the ends where the lintel rests on the walls, provided the opening is not more than 6 feet in width.

All masonry arches shall be capable of sustaining the weight and pressure which they are designed to carry; and the stress at any point shall not exceed the working stress for the material used, as given in section 139 of this Code. Tie-rods shall be used where necessary to secure stability.

Sec. 43. Parapet Walls. All exterior and division or party walls over 15 feet high, excepting where such walls are to be finished with cornices, gutters, or crown mouldings, shall have parapet walls not less than 8 inches in thickness, and carried 2 feet above the roof; but for warehouses, factories, stores, and other buildings used for commercial or manufacturing purposes, the parapet walls shall be not less than 12 inches in thickness, and carried 3 feet above the roof, and all such walls shall be coped with stone, terra-cotta, or cast iron.

Sec. 44. Hollow Walls. In all walls that are built hollow, the same quantity of stone, brick, or concrete shall be used in their construction as if they were built solid, as in this Code provided; and no hollow wall shall be built unless the parts of same are connected by proper ties, either of brick, stone, or iron, placed not over 24 inches apart.

Sec. 45. Hollow Bricks on Inside of Walls. The inside 4 inches of all walls may be built of hard-burnt hollow brick, properly tied and bonded into the walls, and of the dimension of ordinary bricks. Where hollow tile or por-

ous terra-cotta blocks are used as lining or furring for walls, they shall not be included in the measurement of the thickness of such walls.

Sec. 46. Recesses and Chases in Walls. Recesses for stairways or elevators may be left in the foundation (or cellar) walls of all buildings, but in no case shall the walls be of less thickness than the walls of the fourth story, unless reinforced by additional piers with iron or steel girders, or iron or steel columns and girders, securely anchored to walls on each side. Recesses for alcoves and similar purposes shall have not less than 8 inches of brickwork at the back of such recesses; and such recesses shall be not more than 8 feet in width, and shall be arched over or spanned with iron or steel lintels, and not carried up higher than 18 inches below the bottom of the beams of the floor next above.

No chase for water or other pipes shall be made in any pier; and in no wall more than one-third of its thickness. The chases around said pipe or pipes shall be filled up with solid masonry for the space of 1 foot at the top and bottom of each story. No horizontal recess or chase in any wall shall be allowed exceeding 4 feet in length, without permission of the Commissioner of Buildings having jurisdiction. The aggregate area of recesses and chases in any wall shall not exceed one-fourth of the whole area of the face of the wall on any story, nor shall any such recess be made within a distance of 6 feet from any other recess in the same wall.

Sec. 47. Furred Walls. In all walls furred with wood, the brickwork between the ends of wood beams shall project the thickness of the furring beyond the inner face of the wall for the full depth of the beams.

Sec. 48. Light and Vent Shafts. In every building hereafter erected or altered, all the walls or partitions forming interior light or vent shafts shall be built of brick or such other fireproof materials as may be approved by the Commissioner of Buildings having jurisdiction. The walls of all light or vent shafts, whether exterior or interior, hereafter erected, shall be carried up not less than 3 feet above the

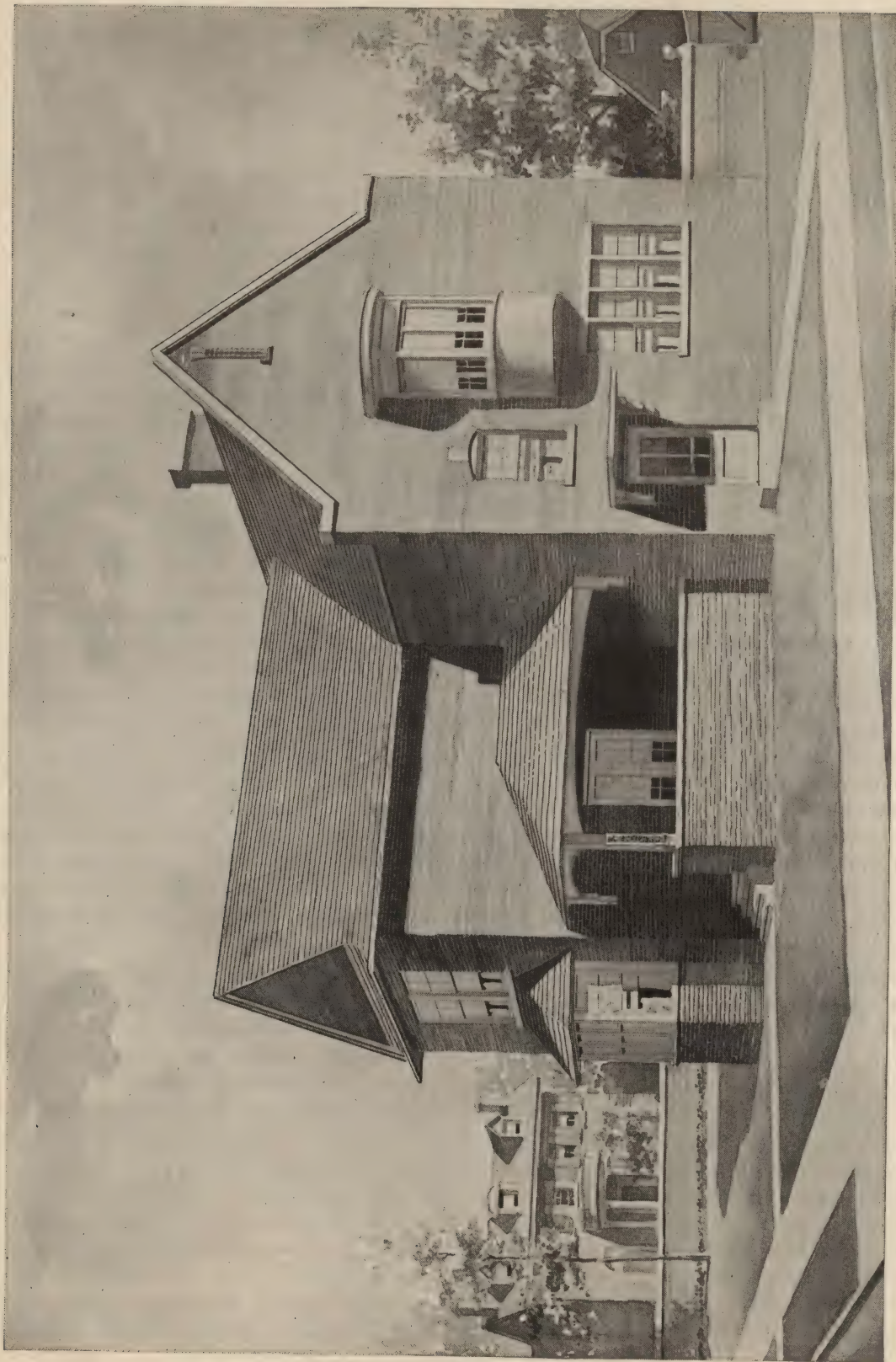


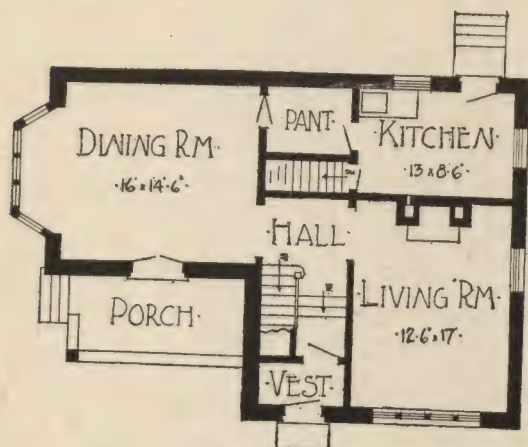
FIG. 58. ATTRACTIVE MODERN DESIGN FOR A SIX-ROOM BRICK HOUSE.

For floor-plans, see page 47.

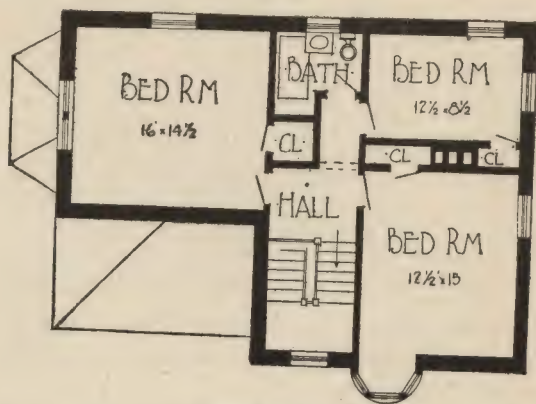
level of the roof, and the brick walls coped as other parapet walls. Vent shafts to light interior bathrooms in private dwellings may be built of wood filled in solidly with brick or hard-burnt clay blocks, when extending through not more than one story in height, and carried not less than 2 feet above the roof, covered with ventilating skylight of metal and glass.

columns, or piers of masonry, may be used; or, if iron or steel floor-beams spanning the distance between bearing walls are used of adequate strength to support the stud partitions above in addition to the floor load to be sustained by the said iron or steel beams, then the fore-and-aft brick partition, or its equivalent, may be omitted.

Stud partitions which may be placed in the



First-Floor Plan.



Second-Floor Plan.

FIG. 59. FLOOR-PLANS OF HOUSE SHOWN IN PERSPECTIVE ON OPPOSITE PAGE.

Sec. 49. Brick and Hollow-Tile Partitions.

Eight-inch brick and 6-inch and 4-inch hollow-tile partitions, of hard-burnt clay or porous terra-cotta, may be built, not exceeding in their vertical portions a measurement of 50, 36, and 24 feet respectively, and in their horizontal measurement a length not exceeding 75 feet, unless strengthened by proper cross-walls, piers, or buttresses, or built-in iron or steel framework. All such partitions shall be carried on proper foundations, or on iron or steel girders, or iron or steel girders and columns or piers of masonry.

Sec. 50. Cellar Partitions in Residence Buildings. One line of fore-and-aft partitions in the cellar or lowest story, supporting stud partitions above, in all residence buildings over 20 feet between bearing walls in the cellar or lowest story, hereafter erected, shall be constructed of brick, not less than 8 inches thick, or piers of brick with openings arched over below the under side of the first tier of beams; or girders of iron or steel and iron

cellar or lowest story of any building shall have good, solid stone or brick foundation walls under the same, which shall be built up to the top of the floor-beams or sleepers; and the sills of said partitions shall be of locust or other suitable hardwood; but if the walls are built 5 inches higher of brick than the top of the floor-beams or sleepers, any wooden sill may be used, on which the studs shall be set.

Sec. 51. Main Stud Partitions. In residence buildings where fore-and-aft stud partitions rest directly over each other, they shall run down between the wood floor-beams and rest on the top plate of the partition below, and shall have the studding filled in solid between the uprights to the depth of the floor-beams with suitable incombustible materials.

Sec. 52. Timber in Walls Prohibited. No timber shall be used in any wall of any building where stone, brick, or iron is commonly used, except inside lintels, as herein provided, and brace blocks not more than 8 inches in length.

Table VII indicates the required thickness of brick walls in the different stories of resi-

TABLE VII
Thickness of Brick Walls, Chicago Building Ordinance for Residences, Tenements, Hotels, and Office Buildings
(Thickness given in inches)

NUMBER OF STORIES BASEMENT AND	BASEMENT	STORIES										
		1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
One-Story	12	8										
Two-Story	12	12	8									
Three-Story	16	12	12	8								
Four-Story	20	16	16	12	12							
Five-Story	20	16	16	16	12	12						
Six-Story	20	20	16	16	16	12	12					
Seven-Story	24	24	20	20	16	16	12	12				
Eight-Story	24	24	24	20	20	16	16	12	12			
Nine-Story	28	24	24	20	20	20	16	16	12	12		
Ten-Story	28	24	24	24	20	20	20	16	16	12	12	
Eleven-Story	28	28	24	24	24	20	20	20	16	16	12	12
Twelve-Story	32	28	28	24	24	24	20	20	20	16	16	12

dences, tenements, hotels, and office buildings, according to the Building Ordinance of the City of Chicago, Ill.

Table VIII gives a summary of requirements of the Building Ordinances of various cities in the United States, as to the thickness of brick walls for mercantile buildings and public stables, and (except in Chicago) for all buildings over five stories in height.

Table IX may be taken as a guide to the proper thickness, at the different stories, for residence walls of varying height and length.

The sizes for brick adopted by the National Brickmakers' Association in 1899 were as follows:

Common brick	8 1/4 x 4	x 2 1/4 in.
Face brick	8 3/8 x 4	x 2 3/8 in.
Paving brick	8 1/2 x 4	x 2 1/2 in.
Roman brick	12 x 4	x 1 1/2 in.
Fire-clay brick	9 x 4 1/2	x 2 1/2 in.

All bricks should be sorted into different thicknesses for first-class work.

The weight of brick varies with the make and size. A common brick will weigh from 4 to 4 1/2 pounds, while pressed brick weigh from 5 to 5 1/2 pounds. Paving bricks weigh from 6

TABLE VIII
Thickness of Brick Walls for Mercantile Buildings and Public Stables, and, except in Chicago, for All Buildings Over Five Stories in Height
(Thickness given in inches)

HEIGHT OF BUILDING	STORIES							
	1st	2d	3d	4th	5th	6th	7th	8th
TWO STORIES								
Boston	16	12						
New York	12	12						
Chicago	12	12						
Minneapolis	12	12						
St. Louis	18	13						
Denver	13	13						
San Francisco	17	13						
New Orleans	13	13						
THREE STORIES								
Boston	20	16	16					
New York	16	16	12					
Chicago	16	12	12					
Minneapolis	16	12	12					
St. Louis	18	18	13					
Denver	17	17	13					
San Francisco	17	17	13					
New Orleans	13	13	13					
FOUR STORIES								
Boston	20	16	16	16				
New York	16	16	16	12				
Chicago	20	16	16	12				
Minneapolis	16	16	12	12				
St. Louis	22	18	18	13				
Denver	21	17	17	13				
San Francisco	17	17	17	13				
New Orleans	18	18	13	13				
FIVE STORIES								
Boston	20	20	20	20	16			
New York	20	16	16	16	16			
Chicago	20	20	16	16	16			
Minneapolis	20	16	16	12	12			
St. Louis	22	22	18	18	13			
Denver	21	21	17	17	13			
San Francisco	21	17	17	17	13			
New Orleans	18	18	18	13	13			
SIX STORIES								
Boston	24	20	20	20	20	16		
New York	24	20	20	20	20	16	16	
Chicago	20	20	20	16	16	16	16	
Minneapolis	20	20	16	16	16	12	12	
St. Louis	26	22	22	18	18	13	13	
Denver	26	21	21	17	17	13	13	
San Francisco	21	21	17	17	17	13	13	
New Orleans	22	18	18	18	13	13	13	
SEVEN STORIES								
Boston	24	20	20	20	20	20	16	
New York	28	24	24	20	20	20	16	16
Chicago	20	20	20	20	16	16	16	16
Minneapolis	20	20	20	16	16	16	12	12
St. Louis	26	26	22	22	18	18	13	13
Denver	26	21	21	21	17	17	17	17
New Orleans	22	22	18	18	18	13	13	13
EIGHT STORIES								
Boston	28	24	20	20	20	20	20	16
New York	32	28	24	24	20	20	16	16
Chicago	24	24	20	20	20	16	16	16
Minneapolis	24	20	20	20	16	16	16	12
St. Louis	30	26	26	22	22	18	18	13
Denver	30	26	21	21	21	17	17	17
New Orleans	22	22	22	18	18	18	13	13

Table VIII—Concluded

HEIGHT OF BUILDING	STORIES											
	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th
NINE STORIES												
Boston	28	24	24	20	20	20	20	20	16			
New York	32	32	28	24	24	20	20	16	16			
Chicago	24	24	24	20	20	16	16	16	16			
Minneapolis	24	24	20	20	20	16	16	16	12			
St. Louis	30	30	26	26	22	22	18	18	13			
Denver	30	26	26	21	21	21	17	17	17			
TEN STORIES												
Boston	28	28	24	24	20	20	20	20	16			
New York	36	32	32	28	24	24	20	20	16	16		
Chicago	28	28	24	24	24	20	20	20	16	16		
Minneapolis	24	24	24	20	20	16	16	16	12			
St. Louis	34	30	30	26	26	22	22	18	18	13		
Denver	30	30	26	26	21	21	21	17	17	17		
ELEVEN STORIES												
Boston	36	32	32	28	28	24	20	20	20	16		
New York	36	36	32	28	28	24	24	20	20	16	16	
Chicago	28	28	24	24	24	20	20	20	16	16		
St. Louis	34	34	30	30	26	26	22	22	18	18	13	
Denver	30	30	26	26	26	21	21	21	17	17	17	
TWELVE STORIES												
Boston	36	36	32	32	28	28	24	20	20	20	16	
New York	40	36	36	32	32	28	24	24	20	20	16	16
Chicago	28	28	28	24	24	24	20	20	20	16	16	16
St. Louis	34	34	34	30	30	26	26	22	22	18	18	13
Denver	30	30	30	26	26	26	21	21	21	17	17	17

to 7 pounds each; and fire-clay bricks, about 7 pounds each.

Weight of Brickwork. The weight of brickwork per cubic foot varies both with the quality of brick and with the thickness of mortar joints. A fair average value for common bricks laid in lime mortar is about 120 pounds per cubic foot. When laid in cement mortar, a cubic foot of common brickwork weighs about 130 pounds. Paving brick weighs about 160 pounds per cubic foot.

Some authorities consider that 112 pounds per cubic foot is plenty to allow for the weight of brickwork; and it is often stated upon that basis, that the weights of brickwork per square foot of wall surface for different thicknesses of wall are as given on page 38. The terms "9-inch wall," "13-inch wall," etc., may be used in some localities as 8-inch wall, 12-inch wall, etc., figuring the wall thickness as if made up of whole bricks and half-bricks.

In laying of brickwork, the lower

TABLE IX

Number of Stories of Different Thicknesses in Residence Walls of Various Heights and Lengths

Height of Wall—Feet	LENGTH OF WALL Feet	Number of Stories of Different Thickness					
		28 in.*	24 in.*	20 in.*	16 in.*	12 in.*	8 in.*
100	45.....	...	...	2	3	Remainder	.....
	80.....	...	2	2	2	"	.....
	Over 80	1	2	2	2	"	.....
90	45.....	...	...	2	2	"	.....
	70.....	...	1	2	2	"	.....
	Over 70	1	2	1	2	"	.....
80	40.....	...	...	1	2	"	.....
	60.....	...	2	2	2	"	.....
	Over 60	...	1	2	2	"	.....
70	40.....	...	...	2	2	"	.....
	55.....	...	...	1	2	"	.....
	Over 55	...	1	2	1	"	.....
60	30.....	...	...	...	1	"	.....
	50.....	...	...	...	2	"	.....
	Over 50	...	...	1	2	"	.....
50	30.....	...	...	...	...	Below top story	Top story
	45.....	...	...	...	1	"	"
	Over 45	...	...	1	1	Remainder	.....
40	35.....	...	...	...	...	Below upper two stories	Upper stories
	Over 35	...	...	...	1	Below top story	Top story
30	35.....	...	...	...	...	Below upper two stories	Upper stories
	Over 35	...	...	...	...	Below top story	Top story
25	30.....	...	...	...	...	.....	All
	Over 30	...	...	...	...	Below top story	Top story

*See statement on page 39 as to the method of considering thickness of building walls.

bricks are subjected to the weight of all brickwork above the lower courses, together with weights of roof, floors, etc., and should be figured to see if their strength is sufficient to carry these pressures. Common brick in lime mortar will hold about 100 lbs. per square inch; when laid in cement mortar, about 150 lbs. per square inch. Hard-burnt and paving bricks laid in cement mortar will hold about 200 to 250 lbs. per square inch.

Pressed Cement Brick

Table X will be found useful in estimating the quantities and cost of materials required for the manufacture of pressed cement brick.

TABLE X
Material Required for 1,000 Pressed Cement Brick

Parts of sand to one of cement.....	1.	2.	3.	4.	5.	6.	7.
Cement, barrel (380 lbs. net).....	6.30	4.25	3.	2.5	2.	1.5	1.40
Cement, lbs.....	2,400.	1,610.	1,150.	910.	750.	643.	562.
Sand, cu. yd. (basis of 110 lbs. cu. ft.)	.88	1.10	1.16	1.22	1.25	1.29	1.32
Cost of materials required per 1,000 brick, at price below for cement and sand .....	.....	.....	.....	.....	.....	.....	.....
Local cost of Portland cement per barrel .....	.....	.....	.....	.....	.....	.....	.....
Local cost of sand per cubic yard...	.....	.....	.....	.....	.....	.....	.....

In the above table the cost spaces (per 1,000 brick) are left vacant so that they may be filled in by the contractor or builder for his own locality.

For example, if a 1:3 brick is desired, with cement at \$1.20 per barrel, and sand at \$1.00 per cubic yard,

the above table shows that approximately 3 barrels of cement and 1.16 cubic yards of sand will be needed. Therefore the approximate cost per 1,000 bricks will be:

$3 \times \$1.20 + 1.16 \times \$1.00 = \$4.76$

Labor in Laying Brickwork

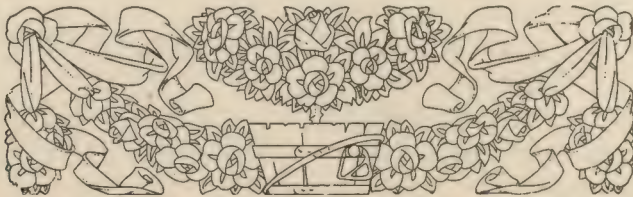
Since the price of labor and the length of working day vary so greatly in different parts of the country, no attempt will be made to give absolute prices for labor in laying brickwork. Instead of actual figures, there will be given the number of bricks that an average workman should be able to lay in a given length of time on a stated class of work. Knowing local rates of wages and hours in a working day, the contractor should be able to judge with a fair degree of correctness as to the probable cost of the work in hand.

In wall construction, there are generally allowed from 1 to 1½ laborers for each brickmason. These men provide the mason with all necessary material, and leave it in a place convenient for

use. The wages of these laboring men, added to the wages of the brickmasons, and divided by the number of thousand brick laid in the wall in a day, would give the cost of laying per thousand.

The following list of different types of work, indicating the actual number of bricks that can fairly be expected to be laid per day by the average workman, will be of service in estimating. An average man will lay:

- 1,200 bricks in plain wall in 8-hour day.
- 2,000 bricks in heavy work in 8-hour day.
- 1,800 bricks in arches in 9-hour day.
- 3,500 bricks in sewers in 8-hour day.
- 7,000 bricks in pavements in 10-hour day.
- 600 bricks in small chimneys in 9-hour day.
- 450 bricks in pressed work in 8-hour day.
- 400 bricks in veneer work in 8-hour day.



Cost of Brickwork

Although attention has been called to the fact that the cost of bricks and brickwork will vary in different localities, the following prices may be used for rough estimates:

Brick, common, \$6.00 to \$10.00 per cubic yard. Cost of lime mortar per cubic yard of brickwork, about 60 cents; of cement mortar, \$1.00 to \$2.00.

On the basis of \$7.25 per thousand for red brick, \$2.50 per barrel for cement, \$1.25 per barrel for lime, \$1.25 per cubic yard for sand, assuming a mason at 65 cents per hour, with help at 37½ cents per hour, to lay 1,200 bricks in 8 hours, a brick wall 13 inches thick will cost about 40 cents per superficial foot. With pressed-brick face, the cost will be about 50 cents per superficial foot.

For close figuring, the methods given below in detail should be followed:

Methods of Measuring Brickwork

The methods of measuring brickwork in walls and in construction work vary with different contractors and in different parts of the country. Many use a rough rule of measuring around the walls, multiplying this measurement by the height, and then multiplying by the number of bricks contained in a square foot of wall of the thickness to be used. They make no allowance for windows, doors, or openings of any kind, of an area less than about 80 square feet, since they claim that the labor necessary around such openings will offset the saving in the bricks which are not used.

As a means of compensating for this seemingly large estimate on the amount of brickwork, some contractors do not allow extras for arches, pilasters, etc.

If deductions are made for openings larger than 80 square feet, contractors using the above method generally measure the width as 2 feet less than the actual width. A rule among some contractors is to figure all walls as solid, and then make an allowance for mortar.

Another method in common use—and one which seems to be a little more rational and conservative while not claiming to be exact—is to measure the actual wall surface, deducting all openings over 2 feet square, measuring the corners only once for brick walls, and then multiplying by 7½ for a 4-inch wall; by 15 for an 8- or 9-inch wall; by 22½ for a 12- or 13-inch wall; by 30 for a 16- or 18-inch wall; by 38 for a 20-inch wall; and by 45 for a 24-inch wall. The results of such a procedure will give the approximate number of “eastern” bricks in the wall. Deduct about 1/3 the number if “western” bricks are used. Table XI may be used to advantage in figuring by this method.

In the Western States the terms **wall measure** and **kiln count** are often heard. “Wall measure” is simply a common trade rule and is not exact. Amounts of brickwork are calculated by the arbitrary rule of 22½ bricks per sq. ft. of wall surface for a 12-inch wall just referred to and as shown in Table XI. This method is often insisted upon by workmen as the basis for computing labor in laying brickwork. Contractors often use this method of estimating number of bricks in figuring cost of brickwork, and then do not figure for cost of mortar; allowing the extra number of bricks figured over the number

TABLE XI
Number of Common Bricks Required for Walls
of Different Thicknesses

SURFACE AREA OF WALL (Square Feet)	NUMBER OF BRICKS NEEDED FOR THICKNESS OF					
	4 in.	8 in.	12 in.	16 in.	20 in.	24 in.
1	7	15	23	30	38	45
2	15	30	45	60	75	90
3	23	45	68	90	113	135
4	30	60	90	120	150	180
5	38	75	113	150	188	225
6	45	90	135	180	225	270
7	53	105	158	210	263	315
8	60	120	180	240	300	360
9	68	135	203	270	338	405
10	75	150	225	300	375	450
20	150	300	450	600	750	900
30	225	450	675	900	1,125	1,350
40	300	600	900	1,200	1,500	1,800
50	375	750	1,125	1,500	1,875	2,250
60	450	900	1,350	1,800	2,250	2,700
70	525	1,050	1,575	2,100	2,625	3,150
80	600	1,200	1,800	2,400	3,000	3,600
90	675	1,350	2,025	2,700	3,375	4,050
100	750	1,500	2,250	3,000	3,750	4,500
200	1,500	3,000	4,500	6,000	7,500	9,000
500	3,750	7,500	11,250	15,000	18,750	22,500
600	4,500	9,000	13,500	18,000	22,500	27,000
900	6,750	13,500	20,250	27,000	33,750	40,500
1,000	7,500	15,000	22,500	30,000	37,500	45,000

actually needed for the wall, to take the place of the cost of the mortar and possibly a part of the labor. If bricks were ordered by this rule, there would be a greater number than needed for the work.

“Kiln count” means the actual number of bricks needed for the work, or the number to be purchased. If kiln count is used, mortar will have to be figured separately, as no allowance is made. The size of brick should always be specified in figuring. For standard bricks, $8\frac{1}{4}'' \times 4'' \times 2\frac{1}{4}''$, 17 is the number usually estimated as occupying 1 square foot of 12-inch wall when joints are thick, that is, between $\frac{3}{8}$ - and $\frac{1}{2}$ -inch.

Sometimes the actual wall contents are measured in **cubic yards of volume**, and the following plan used. For common brick $8\frac{1}{4} \times 4 \times 2\frac{1}{4}$ inches in size, allow 500 bricks to a cubic yard of wall when $\frac{3}{8}$ -inch mortar joints are used. In work where thin joints are used—

as, for example, in fronts, where a $\frac{1}{8}$ -inch joint may be used—it is better to figure on about 580 bricks for a cubic yard of wall.

Hollow walls are generally figured as solid.

Arches are figured from the spring; and pillars or columns may be figured as a wall of length equal to the width and height of the pillar and of thickness equal to the third dimension of same.

When stonework, such as sills, caps, etc., is set by the brickmason, no deduction is made for same in figuring brickwork for walls. The same conditions apply to ashlar work when placed by the bricklayers.

An allowance of 5 or 6 per cent should be made on all figured amounts of brickwork to make up for loss and breakage. A common rule in fancy bricklaying is to add 50 per cent to the figured number of bricks, or allow $1\frac{1}{2}$ bricks for each one actually estimated.

A method of measuring footings together with walls is to add the width of the projections of the footing on each side of the wall to the height of the wall, and figure as indicated above for an ordinary wall.

In figuring the number of bricks needed for piers of considerable size, and where the bulk of the mortar used in the joints will prove a considerable factor, it would be safer to figure the cubic contents of the pier in cubic feet, and divide by 27 to reduce to cubic yards. Then apply the rule of 500 bricks to a cubic yard as already given.

If western brick are used, Table XII will be of service in determining the number of bricks needed. If common bricks are to be used, $8\frac{1}{4} \times 4 \times 2\frac{1}{4}$ inches in size, add $\frac{1}{3}$ to the number given in the table for a given size of pier.

TABLE XII

Number of Bricks Required in Brick Piers

(Western size of brick, $8\frac{1}{2} \times 4\frac{1}{8} \times 2\frac{1}{2}$ inches)

SIZE OF PIER (INCHES)	NUMBER OF BRICKS TO EACH FOOT IN HEIGHT	SIZE OF PIER (INCHES)	NUMBER OF BRICKS TO EACH FOOT IN HEIGHT	SIZE OF PIER (INCHES)	NUMBER OF BRICKS TO EACH FOOT IN HEIGHT
$8\frac{1}{2} \times 8\frac{1}{2}$	8	$22 \times 30\frac{1}{2}$	70	$35 \times 52\frac{1}{2}$	192
$8\frac{1}{2} \times 13$	12	22×35	80		
$8\frac{1}{2} \times 17\frac{1}{2}$	16	$22 \times 39\frac{1}{2}$	90	$39\frac{1}{2} \times 39\frac{1}{2}$	162
$8\frac{1}{2} \times 22$	20			$39\frac{1}{2} \times 44$	180
$8\frac{1}{2} \times 26\frac{1}{2}$	24	$26\frac{1}{2} \times 26\frac{1}{2}$	72	$39\frac{1}{2} \times 48$	198
		$26\frac{1}{2} \times 30\frac{1}{2}$	84	$39\frac{1}{2} \times 52\frac{1}{2}$	216
13×13	18	$26\frac{1}{2} \times 35$	96	$39\frac{1}{2} \times 57$	234
$13 \times 17\frac{1}{2}$	24	$26\frac{1}{2} \times 39\frac{1}{2}$	108		
13×22	30	$26\frac{1}{2} \times 44$	120	44×44	200
$13 \times 26\frac{1}{2}$	36			44×48	220
$13 \times 30\frac{1}{2}$	42	$30\frac{1}{2} \times 30\frac{1}{2}$	98	$44 \times 52\frac{1}{2}$	240
		$30\frac{1}{2} \times 35$	112	44×57	260
$17\frac{1}{2} \times 17\frac{1}{2}$	32	$30\frac{1}{2} \times 39\frac{1}{2}$	126	44×61	280
$17\frac{1}{2} \times 22$	40	$30\frac{1}{2} \times 44$	140		
$17\frac{1}{2} \times 26\frac{1}{2}$	48	$30\frac{1}{2} \times 48$	154	48×48	242
$17\frac{1}{2} \times 30\frac{1}{2}$	56			$48 \times 52\frac{1}{2}$	264
$17\frac{1}{2} \times 35$	64	35×35	128	48×57	286
		$35 \times 39\frac{1}{2}$	144	48×61	308
22×22	50	35×44	160	$48 \times 65\frac{1}{2}$	330
$22 \times 26\frac{1}{2}$	60	35×48	176		

For common size of brick, add $\frac{1}{3}$ to the number of bricks given in table.

The space occupied by 1,000 bricks when carefully stacked, is about 56 cubic feet; while old bricks, when cleaned and stacked loosely, occupy about 72 cubic feet per 1,000.

It is often estimated that a brick-layer's hod will hold about 20 bricks, or about 100 pounds weight. This type of hod is generally about 8 inches on a side and 20 to 22 inches in length.

A mortar hod which is about 12 inches on a side by 22 inches long will hold about $\frac{1}{30}$ of a cubic yard of mortar.

Number of Bricks in a Wall. Table XI will be of service in determining the number of common bricks $8\frac{1}{4} \times 4 \times 2\frac{1}{4}$ inches in size which are needed for walls of ordinary thickness.

For example, supposing that we wish to find from the table the number of bricks in a wall 125 feet long, 15 feet high, and 12 inches thick. This wall

contains $125 \times 15 = 1,875$ square feet.

For 1,000 square feet of 12-inch

wall, the table gives 22,500 bricks

For 600 square feet 13,500 bricks

For 200 square feet 4,500 bricks

For 70 square feet 1,575 bricks

For 5 square feet 113 bricks

Total 1,875 square feet requires

total of 42,188 bricks

This same method can be applied to any size of wall, by simply breaking up the total number of square feet in the wall into parts which are given in the table, and then adding these parts for the final result. This final result is in what is called "wall measure," and not actual number of bricks.

It should be noticed in using this table that the thicknesses of wall are given in multiples of 4 inches, or the width of one brick. By adding the thickness for mortar joints it can be

readily seen as to what column so-called 13-inch walls, 17½-inch walls, etc., will fall under.

For actual number, or "kiln count," multiply this number by 17, and divide by 22½.

Footings. These are wide courses placed at the base of a wall to distribute the pressure over a greater area of ground. The usual practice is to make the lowest footing course twice the

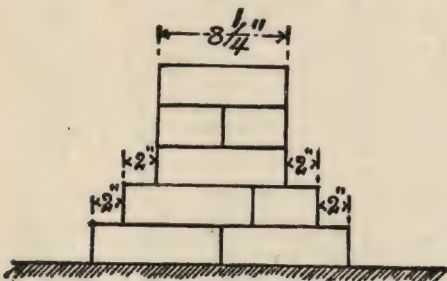


Fig. 60. Brick Footing with 2-Inch Offsets.

width of the wall it is to support. Offsets of 2¼ in. in each superimposed course are then made till the main wall-thickness is obtained. Where walls are two or more brick in thickness, the bottom courses of the footings are frequently doubled. The best practice requires the laying of headers in footings as far as possible, and any stretchers used should be laid near the center of the wall. If the soil is soft and compressible, wider footings should be used. Where the loads are extra heavy, it is recommended that each projecting course be made double, with headers on the top course and stretchers at the bottom. The brick used should be the hardest and strongest the market affords; and special care should be given to the jointing, which should be of cement or hydraulic lime.

Number of Bricks in Footings. When the "standard" size of bricks, 8¼×4×2¼ inches, are used in frontings with offsets of 2 inches for each course used,

Table XIII, based upon the calculation here shown, may be used.

TABLE XIII
Number of Common Bricks in Footings

THICKNESS OF WALL (INCHES)	NUMBER OF COURSES USED IN FOOTING	NUMBER OF BRICKS PER FOOT OF LENGTH IN FOOTING
8	2	10½
12	3	22½
16	4	39
20	5	60
24	6	85½

Fig. 60 shows an 8-inch wall resting upon a footing consisting of 2 courses of brick laid with offsets of 2 inches. There are 3½ bricks shown when looking at the end of this footing. If we stood around on the side of the footing, we would see the ends of 3 bricks 4 inches wide for each foot length of side of footing. Multiplying the number of bricks shown in the end view by the number shown per foot of length in the side view, we would have:

3½×3=10½

bricks per foot length of footing.

With other thicknesses of wall, thicker footings are needed; but the same plan for finding number of bricks per foot length of footing may be used.

For sizes of brick other than that on which Table XIII is based (8¼×4×2¼), the figures there given will be varied to some extent.

Bricks Required for a Chimney. If it is desired to obtain a fairly close estimate as to the number of bricks necessary for a plain chimney, one of the methods described below may be used.

If it is figured that 5 courses of brick laid in a chimney will make 1 foot of height, taking into account the thickness of the mortar joints, and that 5 bricks in a course will make a flue 4×8 inches, then 5×5=25 bricks would be

necessary for 1 foot of height of a chimney with a 4x8-inch flue.

For a flue 8x8 inches, 6 bricks would be needed in each course, or 30 bricks for 1 foot of height.

For a flue 8x12 inches, 7 bricks would be needed in each course, or 35 bricks for 1 foot of height.

For a flue 12x12 inches, 8 bricks would be needed in each course, or 40 bricks for 1 foot of height.

By remembering the size of a common brick, and with the aid of a sketch of the cross-section of the flue desired,

TABLE XIV

Terra-Cotta Flue-Linings

INSIDE MEASURE (INCHES)	OUTSIDE MEASURE (INCHES)	FORM	WEIGHT PER FOOT (POUNDS)	FEET TO CAR-LOAD OF 15 TONS
5	7	Round	14	2,144
6	8	"	19	1,580
8	10	"	22	1,364
10	12½	"	30	1,000
3½x7½	4½x8½	Square	10	3,000
7x7	8½x8½	"	20	1,500
7x11½	8½x13	"	30	1,000
7x15½	8½x17	"	33	910
11½x11½	13x13	"	37	810
11½x15½	13x17	"	40	750
15½x15½	17x17	"	50	600

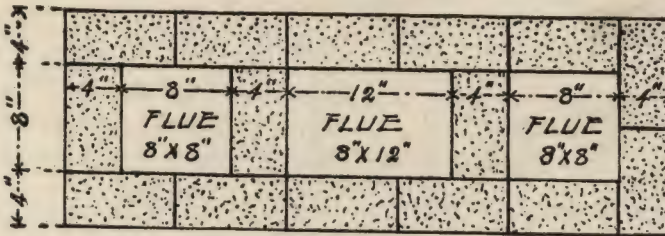


Fig. 61. Section of Brick Chimney with Three Flues.

no matter whether it is a single-, double-, or triple-flue chimney, the above method of figuring the number of bricks needed for any chimney, square or oblong in section, may be used. The method of procedure consists in finding the number of bricks necessary to enclose the area desired, and then multiplying by 5 to get the number of bricks per foot of height of chimney.

For example, suppose it is desired to find the number of bricks needed for a plain chimney 25 feet high and having 2 flues 8x8 inches and 1 flue 8x12 inches.

Lay out a diagram like Fig. 61, and we find that 15 bricks are needed for a course. Then,

$$15 \times 5 = 75,$$

the number of bricks needed per foot of height of chimney, figuring 5 courses of brickwork per foot of length. And,

$$75 \times 25 = 1,875 \text{ bricks,}$$

the approximate total of bricks needed for the chimney.

If fancy designs are used, a special allowance must be made for the same, depending wholly upon the design desired.

A simple method of figuring for single flues is as follows:

Find the number of cubic feet in the chimney by multiplying the area (in square feet) of cross-section of the chimney, considered as solid, by the height in feet; and subtract the contents of the flues as indicated in the following:

For an 8-inch flue, subtract one-half the length of the flue in feet.

For a 12-inch flue, subtract the length of the flue in feet.

For an 18-inch flue, subtract $2\frac{1}{4}$ times the length of the flue in feet.

TABLE XV
Amount of Cement Mortar Required for a
Cubic Yard of Masonry

DESCRIPTION OF MASONRY	MORTAR, CUBIC YARD	
	MINIMUM	MAXIMUM
Ashlar, 18-inch courses, ¼-inch joints.....	.03	.04
Ashlar, 12-inch courses, ¼-inch joints.....	.06	.08
Brickwork (bricks of standard size, 8¼x4x2¼ in.); ½-inch joints.....	.10	.15
¾ to ¼-inch joints.....	.25	.35
¾ to ½-inch joints.....	.35	.40
Rubble, of small rough stones	.33	.40
Rubble, of large stones, rough hammer-dressed...	.20	.30
Squared-stone masonry, 18-inch courses and ¾-inch joints	.12	.15
Squared-stone masonry, 12-inch courses and ¾-inch joints	.20	.25

For a 24-inch flue, subtract four times the length of the flue in feet.

Multiply this answer by 22½, and the result will be the number of bricks required.

ing may be used as a guide in determining the amount of mortar necessary for laying same in wall:

One thousand bricks will require about 1¼ barrels of lime and ¾ of a cubic yard of sand. This may run as low as 1 barrel of lime and 6/10 of a cubic yard of sand.

If laid in 1:2 cement mortar with ⅜-inch joints, 1,000 bricks will require about 1 1/3 barrels of cement and 2 2/3 barrels of sand. With ¼-inch joints, 1,000 bricks will require about 1 barrel of cement and 2 barrels of sand.

If laid in 1:3 cement mortar, with ⅜-inch joints, 1,000 bricks will require about 1 1/9 barrels of cement and 3 1/3 barrels of sand. With ¼-inch joints, 1,000 bricks will require about ¾ of a barrel of cement and 2¼ barrels of sand.

The cost will vary with the prices of above materials in different localities.

Table XV indicates the amount of

TABLE XVI
Materials Used in Coloring Mortars

COLOR	MINERAL	POUNDS COLOR TO 100 POUNDS CEMENT	POUNDS COLOR TO BARREL OF CEMENT
Gray	Germantown Lampblack	¼ to ½	2
Black	Manganese Dioxide	12	48
Black	Excelsior Carbon Black	2	00
Blue	Ultramarine	5 to 6	20
Green	Ultramarine Green	6	24
Red	Iron Oxide	6 to 10	24
Bright Red	Pompeian or English Red	6	24
Sandstone	Red-Purple Oxide of Iron	6	24
Violet	Violet Oxide of Iron.....	6	24
Brown	Roasted Iron Oxide or Brown Ocher.....	6	24
Yellow or Buff.....	Yellow Ocher	6 to 10	24

Table XIV gives sizes and weights of common sizes of terra-cotta flue-linings.

MORTAR FOR MASONRY

After the number of bricks which are to be laid is estimated, the follow-

ing cement mortar required for laying one cubic yard of masonry of various kinds.

Table XVI indicates the kind and amount of coloring material needed for securing various color effects in cement mortar.

HOW TO ESTIMATE BRICKWORK FOR A RESIDENCE

Figs. 62 to 67 show elevations and plans of a substantial, modern brick dwelling-house of 7 rooms, with bath, reception hall, and basement. We shall now endeavor to show the method of procedure to be followed in estimating the cubic foot when laid in wall. If the rule of 500 to the cubic yard, spoken of on page 52 is used, a little larger number of bricks will be needed. If pressed brick is figured, with thin joints in surface work, 17 bricks to the cubic foot

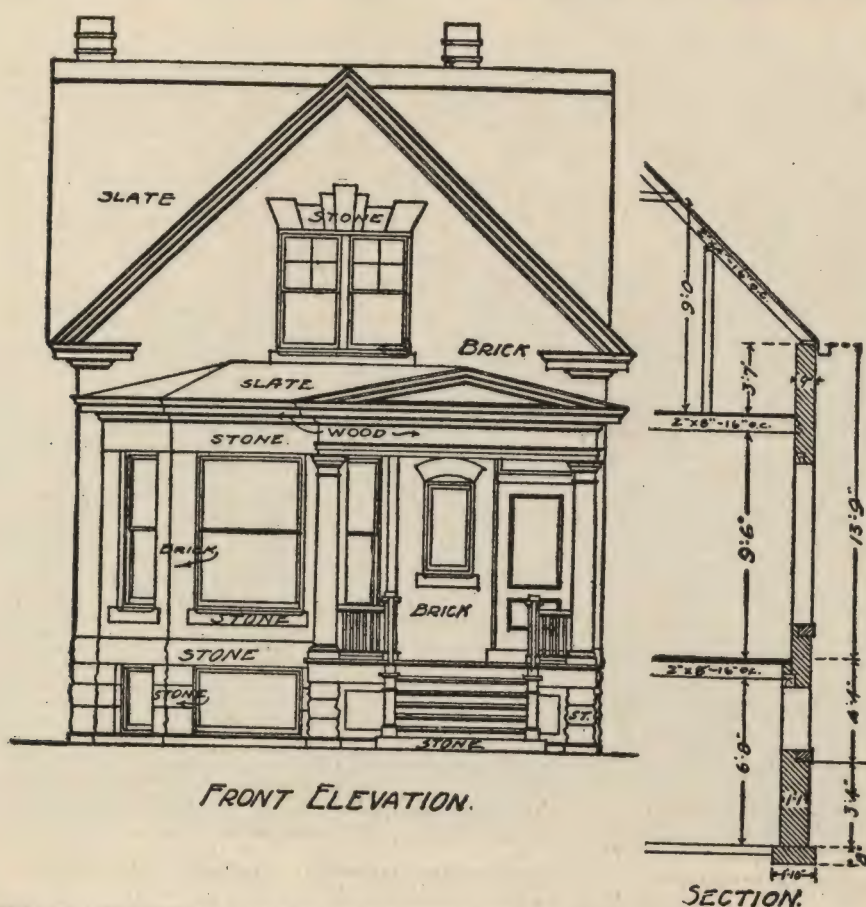


FIG. 62. ILLUSTRATING HOW TO ESTIMATE BRICKWORK FOR A RESIDENCE.
Front elevation and part section. See also Figs. 64 to 67. For photographic view, see Fig. 63.

the number of bricks needed for this house.

Two methods of figuring will be given—first, the **wall measure**, or number of bricks needed on the basis spoken of on page 51, in which connection Table XI is used; and second, the **kiln count**, or actual number of bricks bought and used, figured on a basis of 17 bricks to

will be a little low. The rule of 580 to the cubic yard, or 20 to the cubic foot, will be nearer.

We shall divide the work into parts:

1. All brickwork below top of the first-floor joists;
2. Brickwork above top of first-floor joists;
3. Chimneys;

4. Deduct all openings of over 2 square feet and all stonework.

Brickwork below Top of First-Floor Joists

Footing—The length around the foundation wall is about 121 feet. Thickness of footings, 8 inches, or $\frac{2}{3}$ of a foot; width, 1 foot 10 inches, or 22 inches. Then we have:

Basement Wall—Wall is 13 inches thick, and $7\frac{1}{2}$ feet high to top of first-floor joists. Length around wall is 121 feet.

$121 \times 7\frac{1}{2} = 908$ sq. ft. of wall surface in basement.

From Table XI, for 12-inch wall,

900 sq. ft. = 20,250 bricks

8 sq. ft. = 180 bricks

Total for basement, 20,430 bricks



FIG. 63. ROW OF SUBSTANTIAL MODERN BRICK HOUSES, 7 ROOMS, ON LAFAYETTE AVE., CHICAGO, ILL., BETWEEN 73d AND 74th STREETS.

For elevations and plans, see Figs. 62-67. For estimate on brickwork, see page 57.

$121 \times \frac{2}{3} = 81$ sq. ft. of wall surface in footings.

This will be figured under the 20-inch column in Table XI, since it is 5 bricks thick, with $\frac{1}{2}$ inch allowed for each of 4 joints.

From table for 20-inch wall,

80 sq. ft. = 3,000 bricks

1 sq. ft. = 38 bricks

For footing, 3,038 bricks

Deducting the following window space, allowing 8 inches additional width to windows and 10 inches additional depth, for size of frame opening:

1 space 36" x 38" = 1,368 sq. in.

1 space 54" x 38" = 2,052 sq. in.

2 spaces 32" x 38" = 2,432 sq. in.

1 space 44" x 38" = 1,672 sq. in.

1 space 40" x 38" = 1,520 sq. in.

Total, 9,044 sq. in.

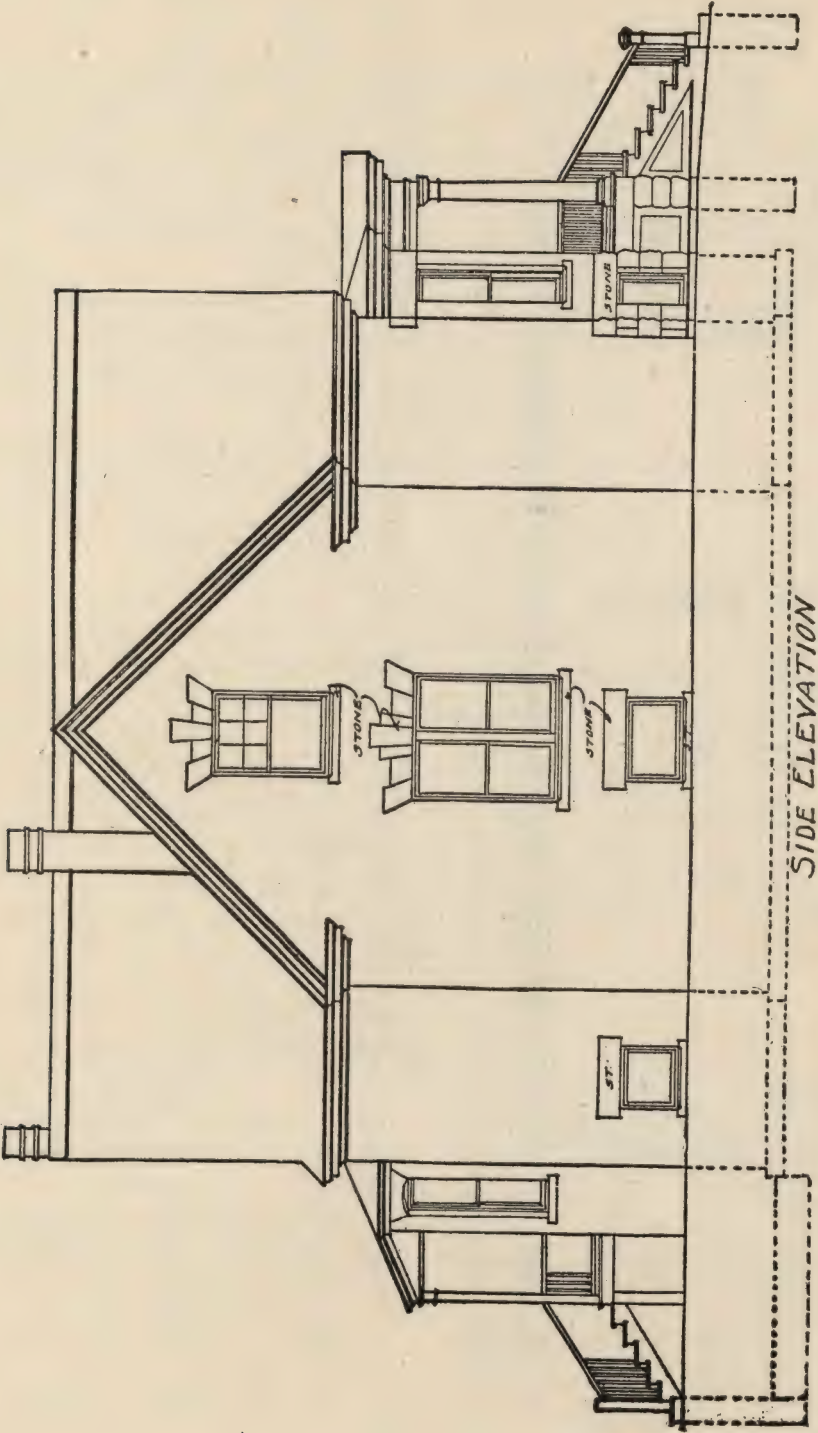


FIG. 64. SIDE ELEVATION OF BRICK HOUSE SHOWN IN FIGS. 62 AND 63.

Dividing this by 144, the number of square inches in a square foot:

$$\frac{9,044}{144} = 63 \text{ sq. ft. of 12-inch wall,}$$

which from the table is equivalent to 1,418 bricks.

Also, deducting for basement door,

$$3 \text{ ft.} \times 7 \text{ ft.} = 21 \text{ sq. ft.,}$$

and 21 square feet of wall surface of 12-inch wall, from the table, is equivalent to 473 bricks.

Total number of bricks to deduct is:

$$1,418 + 473 = 1,891.$$

Thus we have:

$$20,430 - 1,891 = 18,539 \text{ bricks needed in basement wall.}$$

Area-Way Walls—Two walls 11½ feet long by 6 feet high and 13 inches thick.

$$2 \times 11\frac{1}{2} \times 6 = 138 \text{ sq. ft. of wall surface.}$$

From table for 12-inch walls,

$$100 \text{ sq. ft.} = 2,250 \text{ bricks}$$

$$30 \text{ sq. ft.} = 675 \text{ bricks}$$

$$8 \text{ sq. ft.} = 180 \text{ bricks}$$

Total, 3,105 bricks in area-way walls.

Piers—The following piers are called for by the plans:

- 2 16-inch square brick piers at front, 7 ft. high.
- 2 16-inch square brick piers at front, 4 ft. high.
- 2 13-inch square brick piers in cellar, 7 1-3 ft. high.
- 1 16-inch square brick pier at rear, 4 ft. high.
- 1 8x12-inch brick pier at rear, 4 ft. high.

Figuring these as walls either 12 or 16 inches thick as the case may be, we have:

$$7' \times 1\frac{1}{3}' \times 2 = 19 \text{ sq. ft. of wall surface in 2 piers, 16 inches thick.}$$

From table for 16-inch wall,

$$10 \text{ sq. ft.} = 300 \text{ bricks}$$

$$9 \text{ sq. ft.} = 270 \text{ bricks}$$

Total, 570 bricks

Also,

$$4' \times 1\frac{1}{3}' \times 2 = 11 \text{ sq. ft. of wall surface in 2 piers, 16 inches thick.}$$

From table for 16-inch wall,

$$10 \text{ sq. ft.} = 300 \text{ bricks}$$

$$1 \text{ sq. ft.} = 30 \text{ bricks}$$

Total, 330 bricks

Also,

$$7\frac{1}{3}' \times 1' \times 2 = 15 \text{ sq. ft. of wall surface in 2 piers, 12 inches thick.}$$

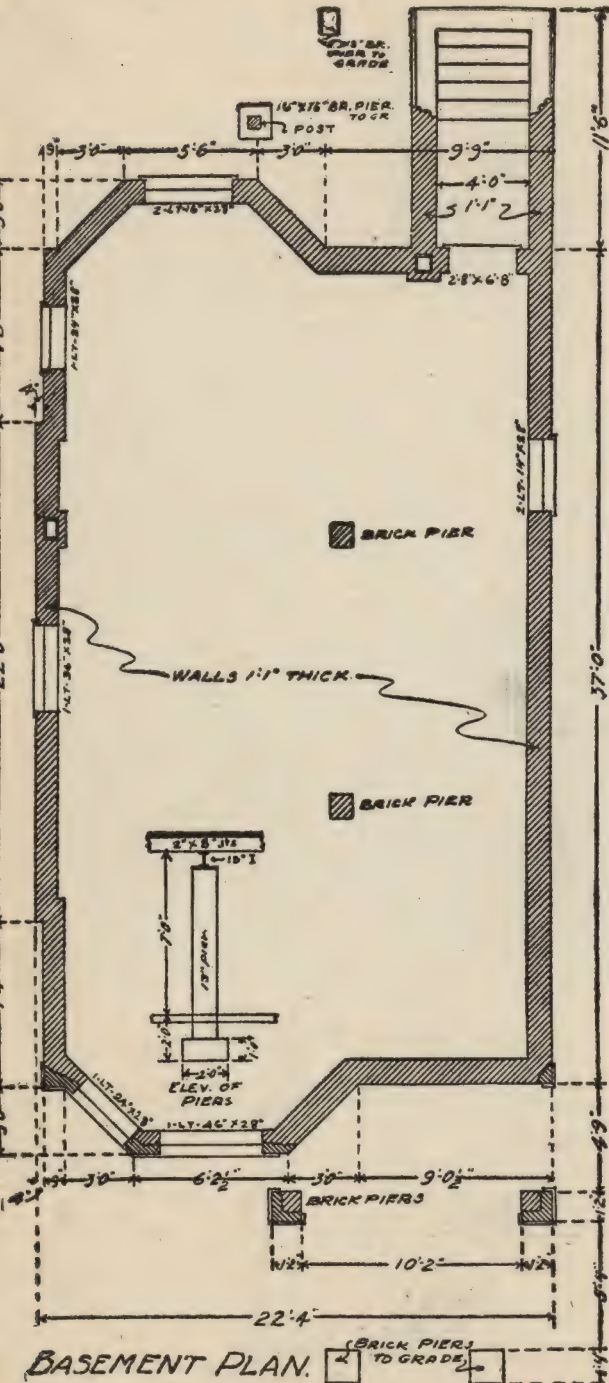


Fig. 65. Basement Plan of Brick House Shown in Figs. 62 and 64.

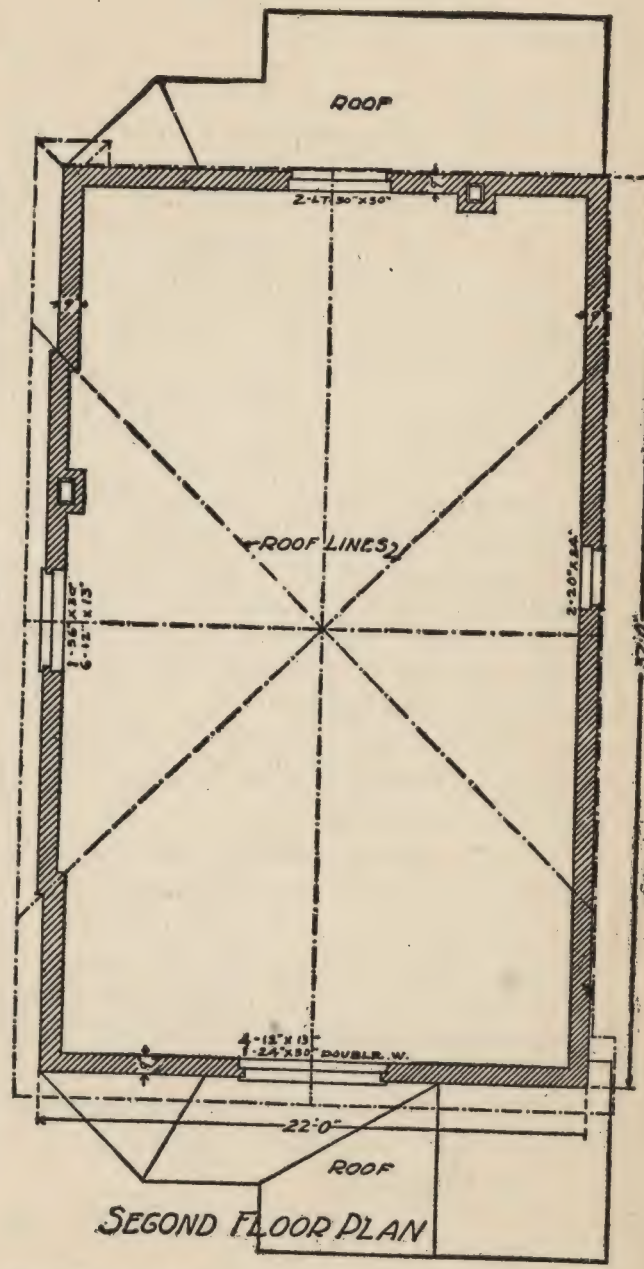
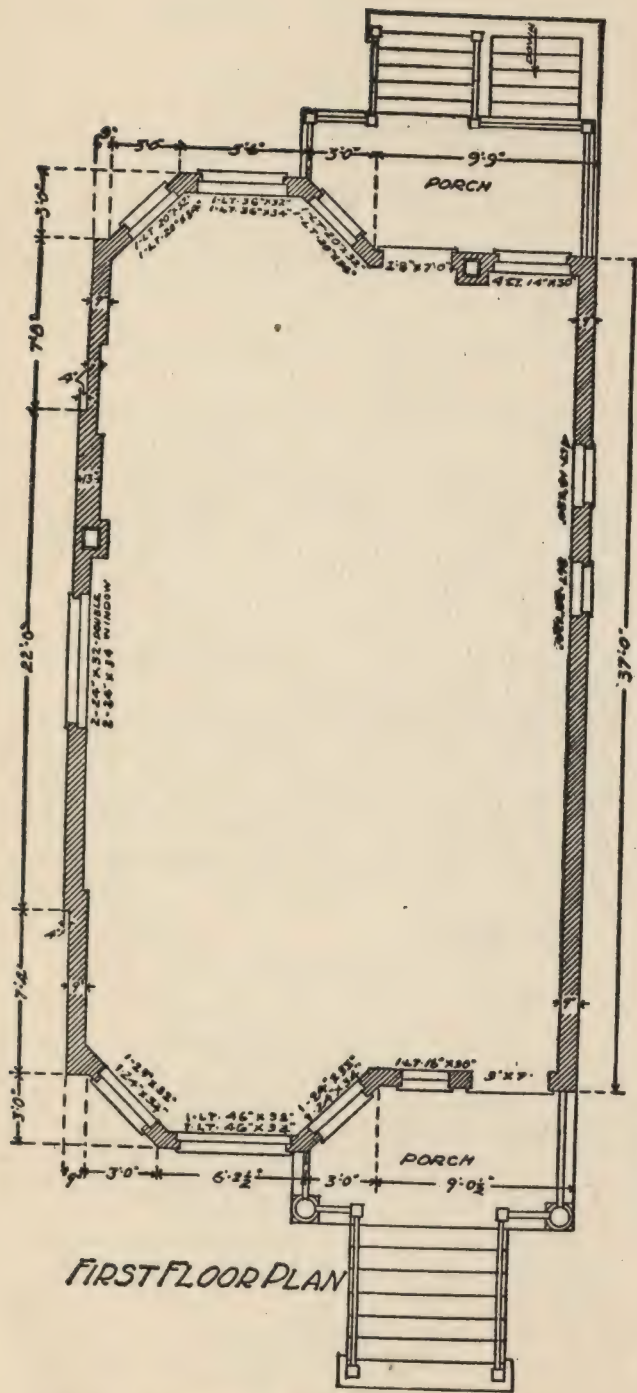


Fig. 62 First-Floor Plan of House Shown in Figs. 62 and 64.

Fig. 67. Second-Floor Plan of Brick House Shown in Figs. 62 and 64.

From table for 12-inch wall,
 10 sq. ft. = 225 bricks
 5 sq. ft. = 113 bricks
 ———
 Total, 338 bricks

Also,

$4' \times 1\frac{1}{3}' = 5\frac{1}{2}$ sq. ft. (nearly) of wall surface 16 inches thick.

From table for 16-inch wall,
 5 sq. ft. = 150 bricks
 $\frac{1}{2}$ sq. ft. = 15 bricks
 ———
 Total, 165 bricks

For the 8x12-inch pier, figure it as a wall 12 inches thick, 4 feet high, and $\frac{2}{3}$ of a foot long:

$4' \times 2\frac{2}{3}' = 3$ sq. ft. (nearly) of wall surface 12 inches thick.

From table for 12-inch wall,
 3 sq. ft. = 68 bricks.

Adding together the various totals for the piers, we have:

Total number of bricks in piers = $570 + 330 + 338 + 165 + 68 = 1,471$ bricks.

For total number of bricks in footings, basement walls, area-way walls, and piers, we have:

$3,038 + 18,539 + 3,105 + 1,471 = 26,153$ bricks.

This is **wall measure**, and not actual number of bricks.

If the **actual number** of bricks is desired, we should proceed as follows:

Find the actual cubic contents of all brickwork, and multiply the result by 17—that is, by the number of bricks contained in a cubic foot of wall with ordinary mortar joints.

The cubic contents will be figured as follows:

Footings—

$121' \times 2\frac{2}{3}' \times 12\frac{2}{3}' = 133$ cubic feet.

Walls—

$121' \times 7\frac{1}{2}' \times 1' = 908$ cubic feet.

Subtracting $(63 + 21) \times 1 = 84$ cubic feet for door and windows, we have:

$908 - 84 = 824$ cubic feet.

Area-Way—

$11\frac{1}{2}' \times 6' \times 1' \times 2 = 138$ cubic feet.

Front Piers—

$7' \times 1\frac{1}{3}' \times 1\frac{1}{3}' \times 2 = 25$ cubic feet.
 $4' \times 1\frac{1}{3}' \times 1\frac{1}{3}' \times 2 = 14$ cubic feet.

Basement Piers—

$7\frac{1}{3}' \times 1' \times 1' \times 2 = 15$ cubic feet.

16-Inch Pier at Rear—

$4' \times 1\frac{1}{3}' \times 1\frac{1}{3}' = 7$ cubic feet.

8x12-Inch Pier at Rear—

$4' \times 1' \times 2\frac{2}{3}' = 2\frac{2}{3}$, or 3 cubic feet.

Total cubic contents,
 $133 + 824 + 138 + 25 + 14 + 15 + 7 + 3 = 1,159$ cubic feet.

Allowing 17 bricks to the cubic foot, we have:

$1,159 \times 17 = 19,703$ bricks

as the actual number of bricks needed below the first floor.

If we wish to check up the wall measure, which was 26,153, by applying the rule of $22\frac{1}{2}$ bricks per cubic foot of wall, we find:

$1,159 \times 22\frac{1}{2} = 26,078$ bricks,

which is very close to the figure found by the use of Table XI.

Walls from Top of First-Floor Joists to Roof. Since the method of procedure has now been outlined, we shall go directly to the house plans for our dimensions in each case, and proceed with less detail.

Side Walls—

$37 \text{ ft.} \times 13\frac{3}{4} \text{ ft.} = 509$ sq. ft.

From table for 8-inch wall,

500 sq. ft. = 7,500 bricks

9 sq. ft. = 135 bricks

—————
 Total, 7,635 bricks

Multiplying this by 2 for 2 walls, we have:

$2 \times 7,635 = 15,270$ bricks.

Add for gables on sides

$22' \times 11' \times \frac{1}{2} = 121$ sq. ft.

(Area of a triangle is equal to one-half the product obtained by multiplying the length of the base by the height.)

From table for 8-inch wall,

100 sq. ft. = 1,500 bricks

20 sq. ft. = 300 bricks

1 sq. ft. = 15 bricks

—————
 Total, 1,815 bricks

Multiplying this by 2 for 2 gables,

$1,815 \times 2 = 3,630$ bricks.

Then,

$$15,270 + 3,630 = 18,900 \text{ bricks.}$$

Deducting opening in walls, making same allowance as before,

$$\begin{aligned} 1 \text{ space } 36'' \times 58'' &= 2,088 \text{ sq. in.} \\ 2 \text{ spaces } 28'' \times 58'' &= 3,248 \text{ sq. in.} \\ 1 \text{ space } 66'' \times 76'' &= 5,016 \text{ sq. in.} \\ 1 \text{ space } 44'' \times 62'' &= 2,728 \text{ sq. in.} \end{aligned}$$

$$\text{Total, } 13,080 \text{ sq. in.}$$

$$13,080$$

$$\text{-----} = 91 \text{ sq. ft. of wall surface.}$$

$$144$$

From table for 8-inch wall,

$$90 \text{ sq. ft.} = 1,350 \text{ bricks}$$

$$1 \text{ sq. ft.} = 15 \text{ bricks}$$

$$\text{Total, } 1,365 \text{ bricks}$$

Deducting 1,365 from 18,900, we have:

$$18,900 - 1,365 = 17,535 \text{ bricks}$$

This is wall measure for side walls of building.

For front and rear end walls, the figuring will be done as follows:

End Walls—Front—

Deduct thickness of side walls, which has already been figured in in getting number of bricks in side walls.

$$20\frac{1}{2}' \times 13\frac{3}{4}' = 282 \text{ sq. ft.}$$

with gable,

$$\frac{1}{2} \times 22' \times 11' = 121 \text{ sq. ft.}$$

$$403 \text{ sq. ft.}$$

Deducting front bay window opening in wall,

$$12' \times 10' = 120 \text{ sq. ft.}$$

$$383 \text{ sq. ft.}$$

Deducting also front door opening,

$$3\frac{1}{3}' \times 7\frac{1}{3}' = 25 \text{ sq. ft.}$$

$$258 \text{ sq. ft.}$$

and deducting windows,

$$1 \text{ space, } 24'' \times 40'' = 960 \text{ sq. in.}$$

$$1 \text{ space, } 66'' \times 62'' = 4,092 \text{ sq. in.}$$

$$5,052 \text{ sq. in.}$$

$$5,052$$

$$\text{-----} = 35 \text{ sq. ft.}$$

$$144$$

$$258 - 35 = 223 \text{ sq. ft.}$$

Add for bricks in front bay window:

$$\text{Length around front bay} = 14\frac{1}{2} \text{ ft.}$$

$$\text{Height} = 10 \text{ ft.}$$

$$14\frac{1}{2}' \times 10' = 145 \text{ sq. ft.}$$

Deduct window openings,

$$1 \text{ space } 54'' \times 76'' = 4,104 \text{ sq. in.}$$

$$2 \text{ spaces } 32'' \times 76'' = 4,864 \text{ sq. in.}$$

$$8,968 \text{ sq. in.}$$

$$8,968$$

$$\text{-----} = 62 \text{ sq. ft.}$$

$$144$$

$$145 - 62 = 83 \text{ sq. ft. of wall surface.}$$

Adding 223 sq. ft. of surface in front wall and 83 sq. ft. in front bay, we have:

$$223 + 83 = 306 \text{ sq. ft.}$$

From table for 8-inch wall,

$$200 \text{ sq. ft.} = 3,000 \text{ bricks}$$

$$100 \text{ sq. ft.} = 1,500 \text{ bricks}$$

$$6 \text{ sq. ft.} = 90 \text{ bricks}$$

$$\text{Total, } 4,590 \text{ bricks}$$

for front end wall of house.

Rear Wall—

$$20\frac{1}{2}' \times 13\frac{3}{4}' = 282 \text{ sq. ft.;}$$

with gable,

$$\frac{1}{2} \times 22' \times 11' = 121 \text{ sq. ft.}$$

$$403 \text{ sq. ft.}$$

Deducting rear bay window opening in wall,

$$11' \times 10' = 110 \text{ sq. ft.}$$

$$293 \text{ sq. ft.}$$

Deducting also rear door,

$$3' \times 7\frac{1}{3}' = 22 \text{ sq. ft.}$$

$$271 \text{ sq. ft.}$$

and deducting window openings,

$$1 \text{ space, } 36'' \times 70'' = 2,520 \text{ sq. in.}$$

$$1 \text{ space, } 38'' \times 70'' = 2,660 \text{ sq. in.}$$

$$5,180 \text{ sq. in.}$$

$$5,180$$

$$\text{-----} = 36 \text{ sq. ft.}$$

$$144$$

$$271 - 36 = 235 \text{ sq. ft. of wall surface.}$$

Add for bricks in rear bay window:

$$\text{Length around rear bay} = 14 \text{ ft.}$$

$$\text{Height} = 9 \text{ ft.}$$

$$14' \times 9' = 126 \text{ sq. ft.}$$

Deduct window openings,

$$2 \text{ spaces, } 28'' \times 76'' = 4,256 \text{ sq. in.}$$

$$1 \text{ space, } 44'' \times 76'' = 3,344 \text{ sq. in.}$$

$$7,600 \text{ sq. in.}$$

$$7,600$$

$$\text{-----} = 53 \text{ sq. ft.}$$

$$144$$

$$126 - 53 = 73 \text{ sq. ft.}$$

Adding 235 sq. ft. of surface in rear wall, and 73 sq. ft. of surface in rear bay, gives:

235 + 73 = 308 sq. ft.
From table for 8-inch wall,
200 sq. ft. = 3,000 bricks
100 sq. ft. = 1,500 bricks
8 sq. ft. = 120 bricks

Total, 4,620 bricks
for rear end wall of house.

Total Wall Measure above First Floor—

Sides	17,535
Front	4,590
Rear	4,620

26,745 bricks

To determine **kiln count**, or actual number of bricks, we may, as before, find the actual cubic contents of the walls above the top of the first floor joists, and then multiply by 17. Or, we may multiply the above "wall measure" number, 26,745, by 17, and divide by 22½.

26,745 × 17
————— = 20,207 bricks, "kiln count."
22½

As a matter of interest and as a check on the work, we shall go back and add up the cubic contents of the walls above the top of the first-floor joists.

From the previous work,

Side walls, sq. ft. = (509 + 121) × 2 =	1,260
Deducting openings, sq. ft.,	91
	1,169
Front wall, sq. ft.,	306
Rear wall, sq. ft.,	308
Total,	1,783 sq. ft.

Multiplying this wall surface by the thickness, 8 inches, or 2/3 foot,

1,783 × 2/3' = 1,189 cubic feet.

Applying the rule of 17 bricks to the cubic foot, we have:
1,189 × 17 = 20,213 bricks, "kiln count,"
which checks approximately with the previous result.

Chimneys—

One chimney 33½ feet high, with 8x12-inch flue: From page 55 we have seen that for an 8x12-inch flue 35 bricks are needed for each foot of height:

33½ × 35 = 1,173 bricks.

One chimney 33½ feet high with 8x8-inch flue:

It has been demonstrated that for an 8x8-inch flue 30 bricks are needed for each foot of height:

33½ × 30 = 1,005 bricks.

Total for 2 chimneys:

1,173 + 1,005 = 2,178 bricks.

If it is desired, these figures may be checked by the chimney rule given on page 54.

Adding the numbers of bricks determined from the previous calculations, we find that the following bricks are needed:

Wall Measure—

Basement and footings	26,153
Above first floor	26,745
Chimneys	2,178
	55,076

Kiln Count—

Basement and footings	19,703
Above first floor	20,207
Chimneys	2,178
	42,088

A nearer approximation may be reached by deducting the volume of the cut stone shown in the plans. The walls thus far have been figured as solid brick, with no notice taken of the stone.

Cut Stone—Front—

Piers:

14" × 4" × 30" =	1,680 cubic inches.
9" × 4" × 30" =	1,080 cubic inches.

Front Wall:

1 piece,	9" × 4" × 30" = 1,080 cubic inches.
1 piece,	6" × 4" × 30" = 720 cubic inches.
1 piece,	6" × 4" × 30" = 720 cubic inches.
1 piece,	12" × 4" × 30" = 1,440 cubic inches.
1 piece,	12" × 4" × 30" = 1,440 cubic inches.
1 piece,	9" × 9" × 30" = 2,430 cubic inches.
1 piece,	75" × 4" × 12" = 3,600 cubic inches.
1 piece,	51" × 4" × 12" = 2,448 cubic inches.
1 piece,	51" × 4" × 12" = 2,448 cubic inches.
1 sill,	60" × 5" × 5" = 1,500 cubic inches.
2 sills,	39" × 5" × 5" = 1,950 cubic inches.
1 sill,	30" × 5" × 5" = 750 cubic inches.
1 sill,	44" × 5" × 10" = 2,200 cubic inches.
1 sill, 2d story,	72" × 5" × 5" = 1,800 cubic inches.
1 flat arch, 72" × 4" × 18" (average height) =	5,184 cubic inches.

(Deduct stone water-table if there is one.)

Side Walls:

1 sill,	32" × 5" × 5" =	800 cubic inches.
1 sill,	42" × 5" × 5" =	1,050 cubic inches.
1 sill,	36" × 5" × 5" =	900 cubic inches.
1 sill,	66" × 5" × 5" =	1,650 cubic inches.
1 sill,	36" × 5" × 5" =	900 cubic inches.
2 sills,	28" × 5" × 5" =	1,400 cubic inches.
1 sill,	44" × 5" × 5" =	1,100 cubic inches.
1 flat arch,	72" × 4" × 18" =	5,184 cubic inches.
1 flat arch,	54" × 4" × 15" =	3,240 cubic inches.
1 lintel,	52" × 4" × 12" =	2,496 cubic inches.
1 lintel,	42" × 4" × 12" =	2,016 cubic inches.
1 lintel,	48" × 4" × 12" =	2,304 cubic inches.

Rear Wall:

1 sill, 40" × 5" × 10" =	2,000 cubic inches.
1 sill, 38" × 5" × 5" =	950 cubic inches.
1 sill, 36" × 5" × 5" =	900 cubic inches.
2 sills 28" × 5" × 5" =	1,400 cubic inches.
1 sill, 44" × 5" × 5" =	1,100 cubic inches.
1 sill, 40" × 5" × 5" =	1,000 cubic inches.

Adding to determine the total volume of stonework, we find the result to be:

62,860 cubic inches.

Dividing this by 1,728, the number of cubic inches in a cubic foot:

62,860

— = 36 (nearly) cubic feet.

1,728

By the rule of $22\frac{1}{2}$ bricks to the cubic foot, we should deduct:

$$22\frac{1}{2} \times 36 = 810$$

bricks from the "wall measure" of 55,076 bricks.

Or, by the rule of 17 bricks to the cubic foot, we should deduct:

$$17 \times 36 = 612$$

bricks from the "kiln count" or actual number used, of 42,088.

This would leave the final result as follows:

Wall measure	54,266 bricks
Kiln count	41,476 bricks

Allowing 5 per cent for breakage on each of the above amounts, we have:

$$54,266 + \frac{5}{100} \times 54,266 = 56,979 \text{ bricks}$$

$$41,476 + \frac{5}{100} \times 41,476 = 43,549 \text{ bricks}$$

These are the approximate numbers needed according to the two meth-

ods of figuring. In practice these numbers would probably be treated as 57 thousand and 44 thousand.

No attempt has been made here to separate the various kinds of brick, as the intention is to show the method of obtaining the number of standard $8\frac{1}{4}$ " x 4" x $2\frac{1}{4}$ " bricks which are needed. By applying the same methods, the number of each kind of brick in a house where several qualities are used, may be found.

On large jobs of brickwork, it is often usual for the contractor to specify a minimum size for the bricks so as to guard against losses from estimating that a certain number of bricks will build a certain number of cubic feet of wall.

Thickness of mortar joints is also a quantity to be figured on in determining actual number of brick. This point was referred to on page 52.

BRICK FOUNDATION WALLS

Thickness. Foundation walls are classed in building codes as all walls and piers built below the curb-level and which support the superstructure. There is no basic rule by means of which the thickness of a brick wall in proportion to its height is determined. The common rules for brick wall foundation thicknesses are that such walls shall be at least 4 inches wider than the walls which rest upon them. This thickness must be maintained for the first 12 ft. of depth of foundation wall, and be increased 4 inches for each 10 feet, or part of 10 feet, of additional depth.

The accompanying table on the thickness of foundation walls for buildings of various heights will be a safe guide to follow where no local building code is in force.

TABLE XVII A
Thickness of Foundation Walls for Buildings
of Various Heights
(No Building Code in Force)

HEIGHT OF BUILDING	DWELLINGS, HOTELS, ETC.		WAREHOUSES	
	BRICK, IN.	STONE AND CONCRETE	BRICK	STONE AND CONCRETE
Two Stories.....	12 or 16	20	16	20
Three Stories.....	16	20	20	24
Four Stories.....	20	24	24	28
Five Stories.....	24	28	24	28
Six Stories.....	28	32	28	32

Good, hard, non-absorptive brick make good foundation walls. A minimum thickness of 12 inches is always assumed for brick foundations.

The thicknesses given in the table are

based upon experience. They are supposed to have large factors of safety. It has been suggested that in any case the results of column-testing may be considered as establishing a definite line of strength, this being that the height of a column shall not exceed 10 times its least dimension. In column-testing, the column will buckle if this proportion is exceeded; if it is not, full compressive resistance will be secured.

FRAMING FOR BRICK HOUSES.

Various types of masonry veneer construction have frequently been employed in many parts of the country, especially in the East, and have gained much popularity. Brick veneer has been most used, though of late years



FIG. 68. HOUSE OF BRICK VENEER CONSTRUCTION IN COURSE OF ERECTION.

concrete blocks and tile have come into use for veneering purposes to some extent. The advantages of any of these systems over the solid masonry wall, for residence work, seems to be a lower first cost and a drier wall; while, as compared with all-frame construction, the veneer is warmer, more durable, and presents a more dignified appearance.

the cellar, absolutely level, in order to support the upper structure of brick. Therefore the foundation wall must not be less than 20 inches thick.

The water-table having been set, and the frame erected to the exact measurements, the first five courses of brick may be laid all the way around, as shown in the elevation, Fig. 69. After

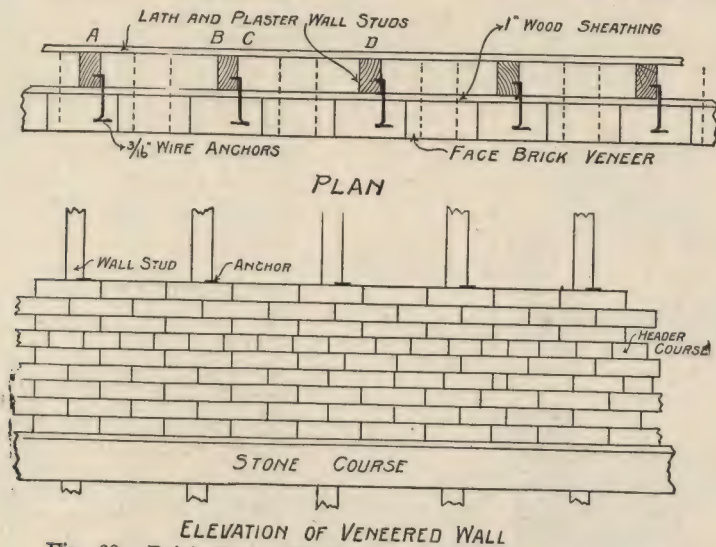


Fig. 69. Brick Veneer Wall Construction, Showing Bonding.

Brick Veneer Wall Construction. In the main, the timber framing to be used with brick veneer construction is identical with the best practice for all-frame houses. A number of points, however, require special attention. The relation of the masonry veneer coat to the studing, and the proper bonding of the masonry and framework, one to the other, is one of these points.

Consider a house which is to be constructed of a wooden frame, sheathed diagonally with inch boards and finished with a brick facing of veneer of 4 inches. In order properly to veneer the wooden or timber work, it is necessary that the frame should be kept at least 6 inches from the outside face of the foundation wall. A water-table course of stone should be carried around above

this is done, wire wall-anchors of the shape indicated upon the plan (which, by the way, can be purchased at any hardware store) are driven into the sides of the studdings 16 inches apart, and laid flat on the top of the bed recourse so as to tie the brickwork firmly to the wooden frame. At the corners, the anchors should be plentifully used.

Should it not be desirable to use the anchors and it be found necessary to make a stronger wall, a course of brick headers, English bond, may be introduced on the sixth course, allowing the headers to pass through the thickness of the studdings and filling up the space between them, as at **AB** and **CD**, with the rough brick. This method gives practically an 8-inch wall, and makes a warmer house, as old brickbats can be

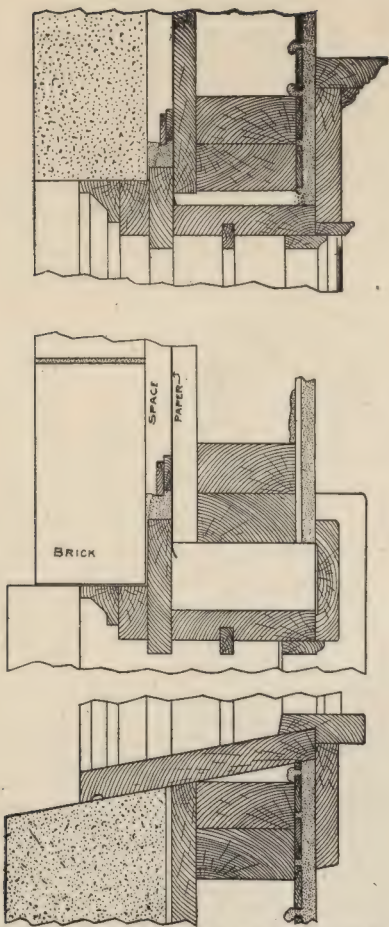


Fig. 70. Wall Section Showing Air-Spaces and Framing.

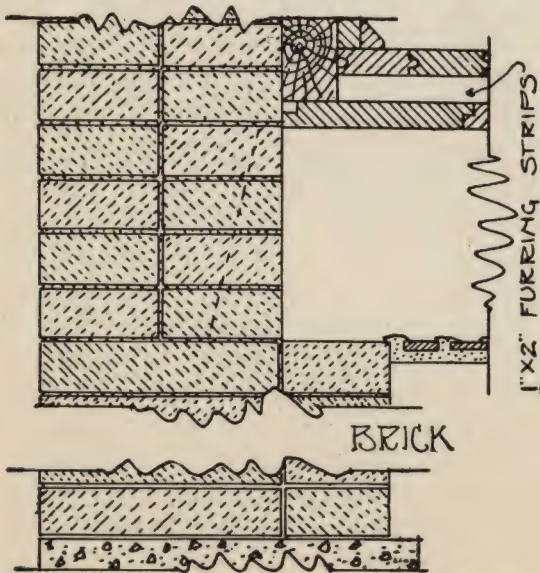


Fig. 71. Brick Wall Section and Approved Sill Construction.

used to great advantage. Should a Flemish bond of headers and stretchers be employed, then the bricks should be placed as indicated by the dotted lines shown in the plan. The thickness of the anchors desired must not be in excess of the brick mortar joints.

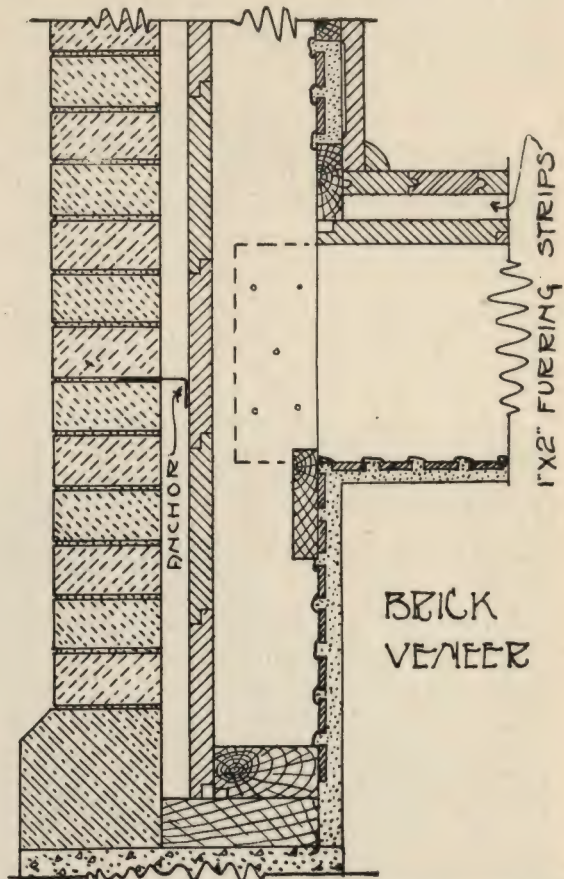


Fig. 72. Brick Veneer Wall Section and Approved Sill Construction.

Should the building be of concrete, veneered with brick, it will be necessary to lay up the brickwork first, before backing-up of the concrete. All measurements must be carefully watched so that the sills, lintels, bond courses, etc., may be at their proper heights and levels. The same rules apply to backing-up with rough rubble stonework; but it is better to build the stonework first, and, by driving hook anchors into

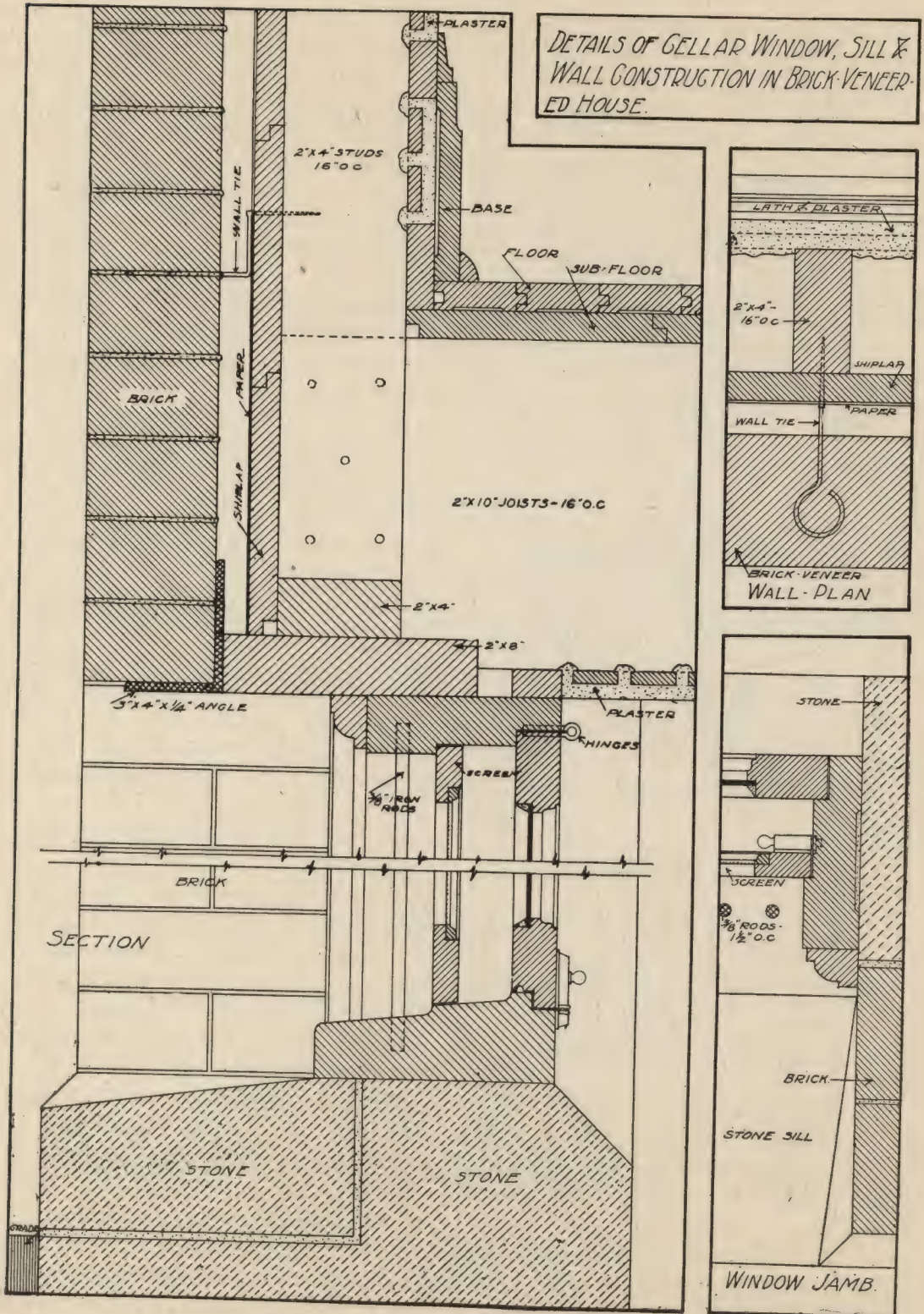


FIG. 73. BRICK VENEER CONSTRUCTION.

Details of approved construction for cellar windows, sills, and walls in the popular type of building of brick veneer over timber frame.

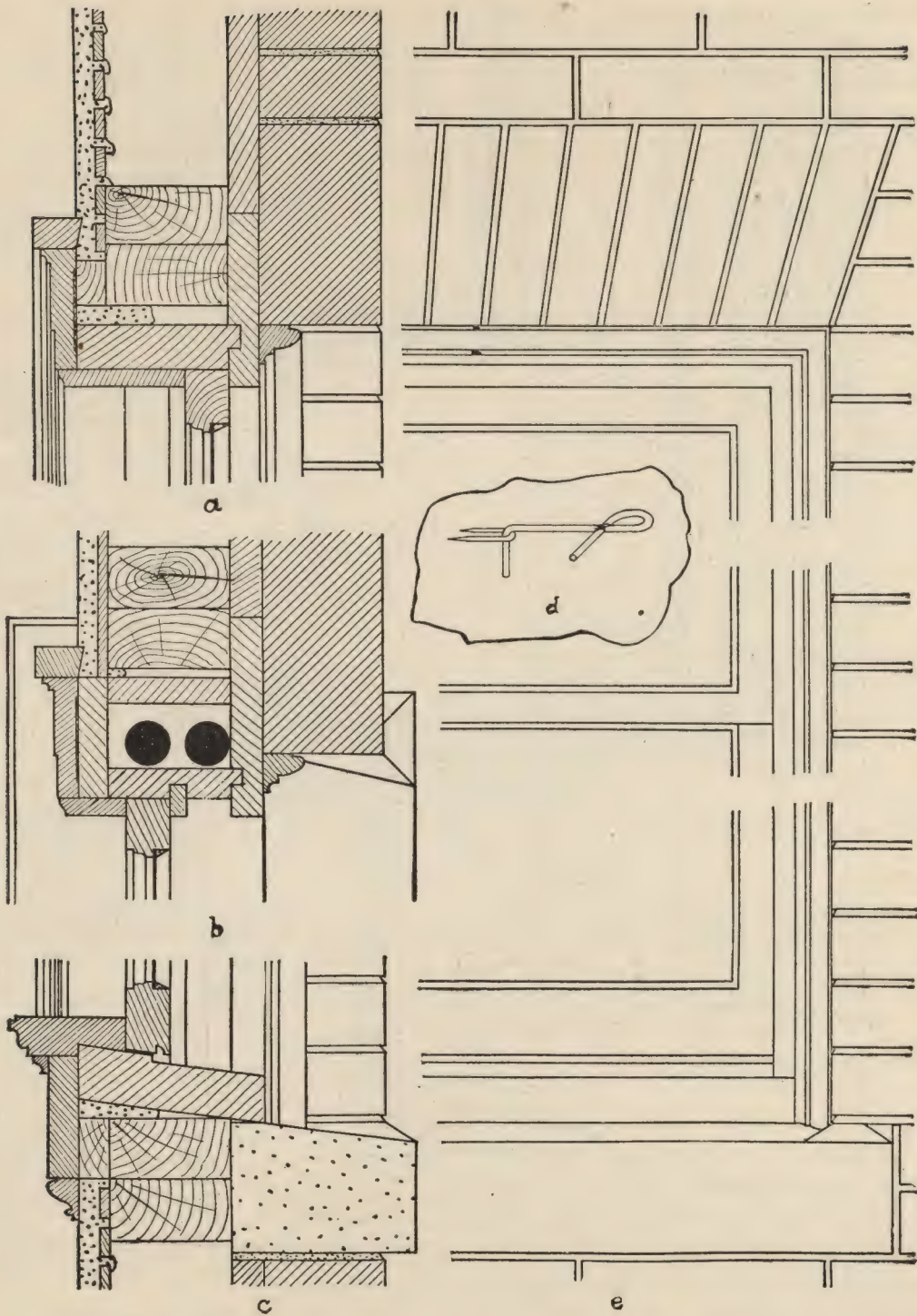


FIG. 74. DOUBLE-HUNG WINDOW IN BRICK-VENEER WALL.

The wall is constructed of 2 by 4 studs, doubled at openings, plastered on the inside, sheathed diagonally on the outside with matched boards; then covered with waterproof sheathing paper, and then with four inches of brickwork. The brick wall is tied to the framework every five courses and opposite every stud. Fig. a, section through window-head. Fig. b, section through jamb. Fig. c, section through sill. Fig. d, detail wall-tie. Fig. e, exterior view.

the variegating joints, obtain a fastening in the brick veneer.

Air-Spaces and Bonding. One of the principal boasts made for the brick veneer type of house is concerning its warmth and dryness. This comes from the ample dead air-spaces. A double air-chamber is made by leaving an air-space between the brick and the sheathing.

Fig. 70 shows in sectional detail how this is done. It is a good idea not to crowd the brick close to the sheathing; better set off an inch or the thickness of the blind stop, and make the same wide enough to lap onto the sheathing. However, the building paper should be put on first; and then, after the window-frames are set, it is a good idea to nail a couple of lath an inch or so back of the blind stop, and fill in with mortar, pressing the same in firmly. This can be done at the time the brick are being laid, with practically no loss of time.

The hollow space serves a double purpose, as it affords a dead air-space, and at the same time allows some leeway in correcting unevenness in the framework. It is also a good idea to cut-in pieces between the joist and studding at the different floors, so as to cut off the circulation in case of fire, as well as prevent the movements of the ever pesky mouse.

The anchoring of the brickwork to the sheathing should be done by stapling wire to the sheathing opposite the studding and about every sixth course apart. The wire should be left loose enough to reach out half the width of the brick, and to be well bedded into the mortar joint. No. 11 wire should be used.

Comparative Cost of Veneer and Solid Brick Construction. The question of comparative costs is one which

the contractor or builder often has to face; and, unless experience has given him the desired knowledge, he is often troubled as to how to proceed in the matter. As an example, we shall show an approximate method of determining the difference in cost between a house in brick veneer construction, and the same size of house in solid brick.

On account of the roof, foundations, floors, windows, doors, all interior finish, etc., being practically the same in each house, we shall confine ourselves to a comparison of the costs of the walls in each form of construction.

The difference in cost of **plain wall construction** for the two forms of construction is approximately as follows:

BRICK VENEER CONSTRUCTION

(Based on cost of face brick at \$21.00 per 1,000)	
Dimension lumber, 8 ft. B. M., at 4c. per ft.	
(in wall)	\$0.32
Sheathing, 10 ft. B. M., at 4c. per ft. (in wall)	.40
Building paper, put on, per yd.	.03
63 face brick, at 3½c. each (in wall)	2.21
Plastering, three coats, per yd.	.26
Total, per sq. yd.	\$3.22

SOLID BRICK CONSTRUCTION

(12-inch wall)

63 face brick, at 3½c. each (in wall) ...	\$2.21
126 common brick, at \$14 per 1,000 (in wall)	1.76
Furring walls, per yd.	.06
Plastering, three coats, per yd.	.26
Total, per yd.	\$4.29

The above figures will give a fair idea of the comparative **wall costs**. Of course, the percentage of the total cost of these two houses will not be directly proportional to these above costs, since the latter are only a part of each total. By adding to each one the cost of floors, roof, interior finish, etc., divided by the

DETAIL OF GORNICE CONSTRUCT-
ION IN BRICK-VENEERED HOUSE.

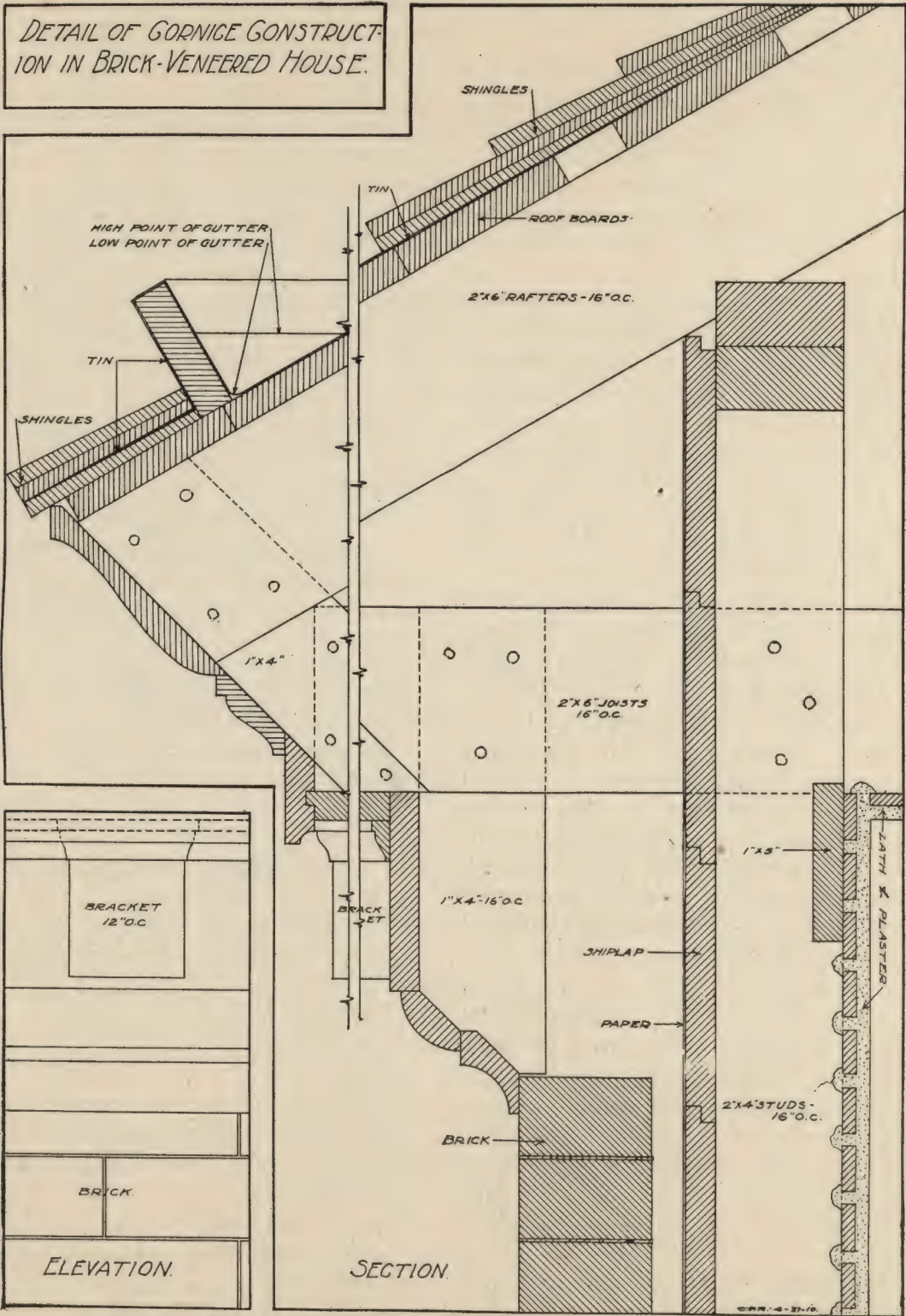


FIG. 75. CORNICE CONSTRUCTION FOR A BRICK-VENEER HOUSE.

Detail showing approved method of framing at the cornice for houses of brick veneer construction.

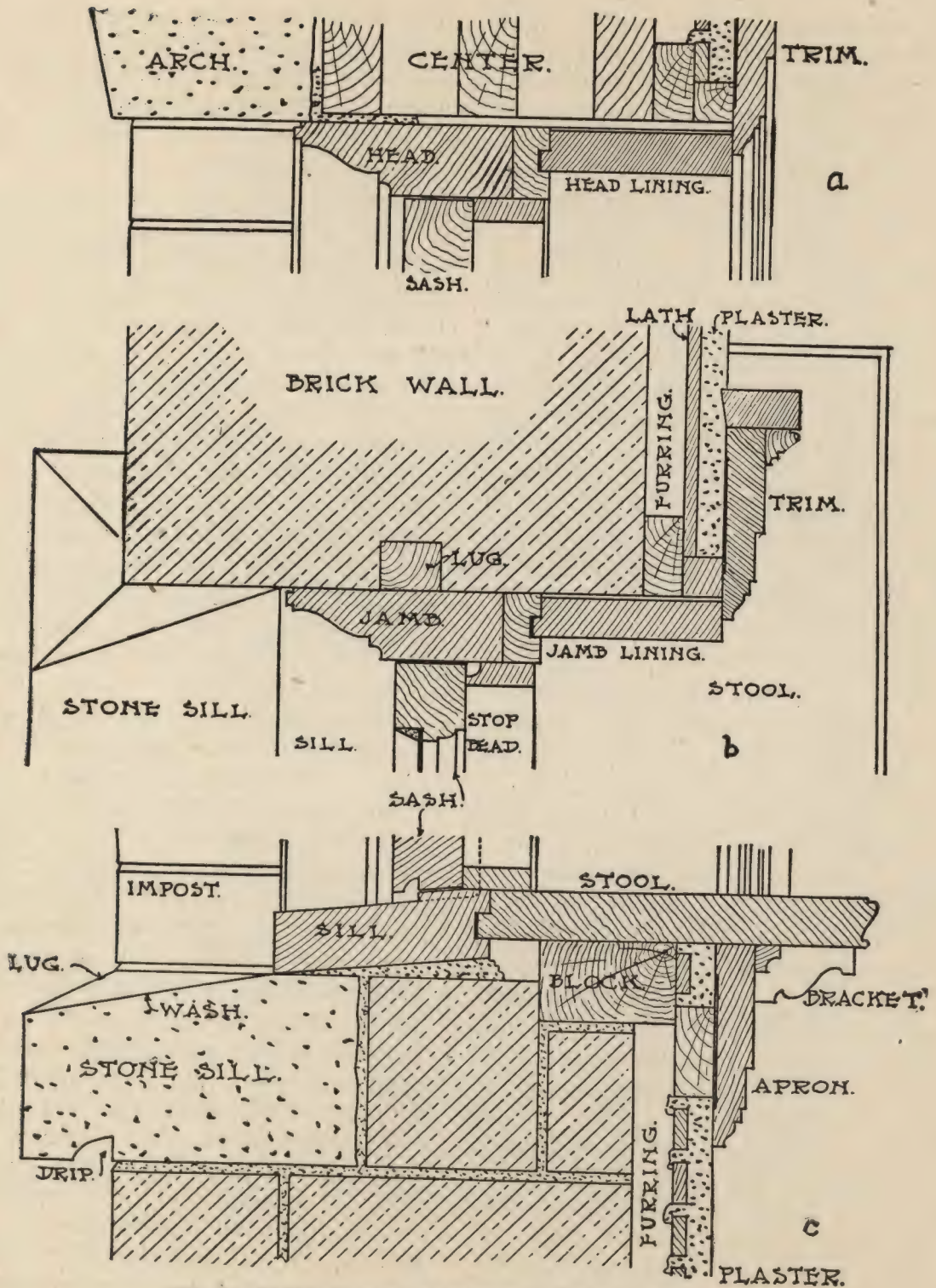


FIG. 76. INEXPENSIVE CASEMENT IN BRICK WALL.

Outward-opening casement of cheap construction; arrangement for 13-inch brick wall. Fig. a, section through window-head. Fig. b, section through window-jamb. Note arrangement of molded stop bead and jamb lining. Fig. c, section through window-sill.

total number of square yards of wall surface, we should then be in a position to give a comparative estimate on the total cost of the forms of construction. This percentage of the total cost is often figured as being 15 to 20 per cent greater for solid brick construction than for veneer.

Window-Framing in Brick Walls.

How window-frames are set, and the woodwork finish attached in masonry walls, is well illustrated in Fig. 76. It shows a casement window opening outward in a 13-inch brick wall. This type of construction is about the cheapest that can well be employed, excepting of course that the molded work and other features which are provided for appearance only may be greatly simplified. These features are subject to considerable modifications as the taste of the architect or builder dictates.

The window opening is spanned on top by a flat stone arch, the blocks of which are cut with a camber of $\frac{1}{4}$ inch and set with a camber of $\frac{1}{8}$ inch to every foot of span. Flat arches set in this manner give a much better effect than when set perfectly flat, inasmuch as the arch appears to sag in the center when the soffit is perfectly straight.

Back of the stone arch, a rowlock arch is turned over a wood center, and supports the inner two-thirds of the wall over the opening. These rowlock arches are segmental in form, and are built of brick set on edge; and one rowlock is provided for every foot in width of the masonry opening. All rowlocks should start at a brick impost cut to a line corresponding with the radius of the arch; and the key bricks of the lower rings should not be set until the upper rings are ready for their key bricks.

The masonry jamb of the opening is

built straight, and the window-frame is secured in place by means of a lug which is left on the jamb of the frame and built into the masonry as the walls are carried up about same. This lug also serves as a wind stop.

The stone sill of the opening is cut so as to lay up accurately with two courses of brickwork, and is tailed into the masonry under each brick impost. The sill is cut with a wash, and has a lug or raised seat at each end to receive the brick imposts. On the under side of the projecting part, a water drip is cut. The stone sill should extend under the wooden sill at least two inches.

At the top, Fig. 76 is a vertical section showing the construction at the head of the frame. The trim is mitered, put together with slip tongues, and glued. The head lining is tongued into a piece of finishing wood on the inside of the frame head.

Below is a horizontal section showing the construction at the jamb of the frame. The frame is moulded, and, where it abuts the stop bead, a channel is provided to catch any water which may beat in between the sash and frame during stormy weather. This channel conveys the water down, and discharges it on the sill. The trim is molded, built up, and hollow-backed, and has a feather-edged back-band.

At the bottom is a vertical section showing the construction at the sill of the frame. The inside stool is tongued into the wooden sill, extended into the room, and provided with brackets. The apron is molded, and has returned ends. A small mold is provided in the angle formed by the intersection of the stool and apron. A water nose is cut on the under side of the bottom rail of sash.

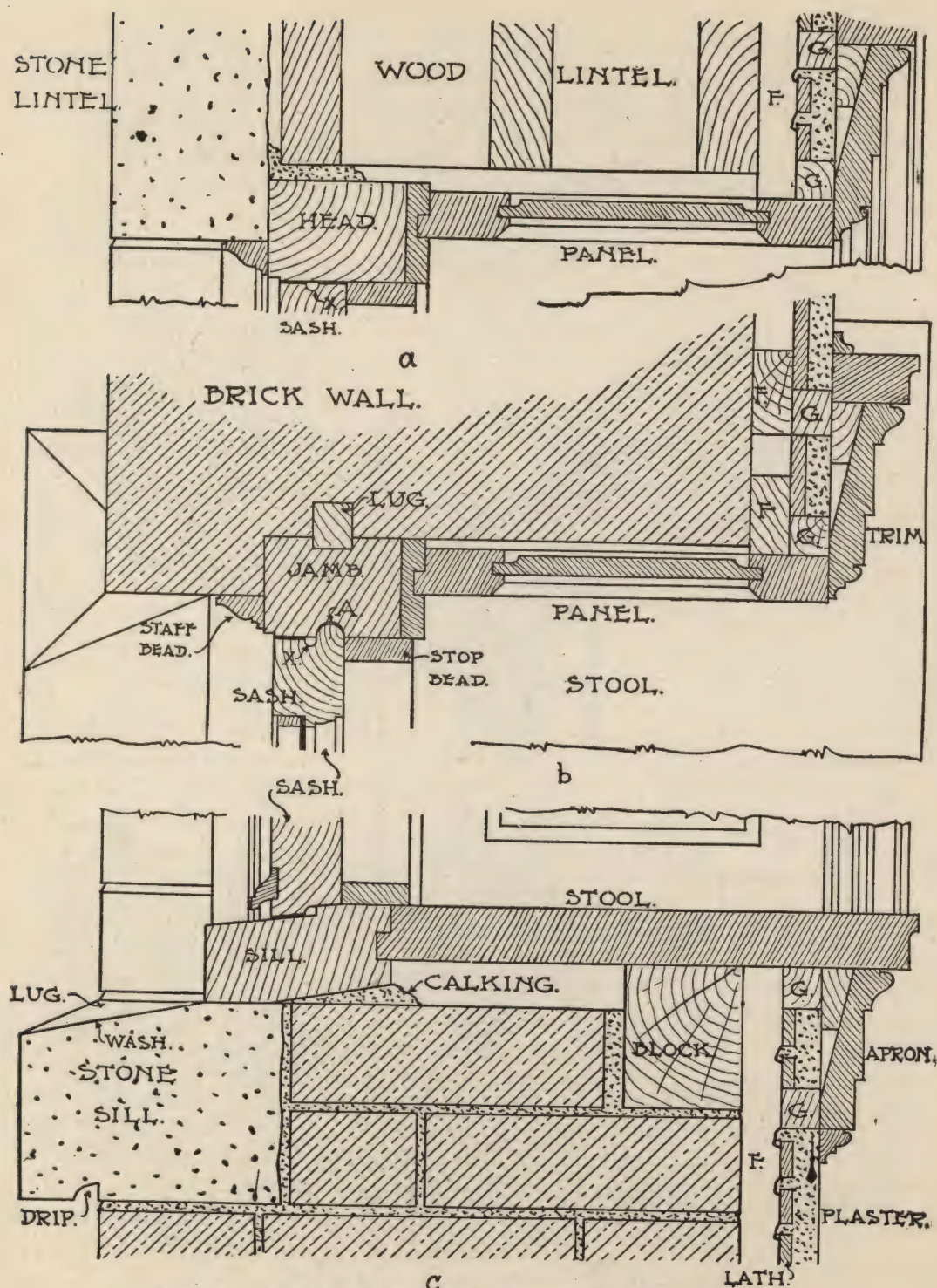


FIG. 77. OUTWARD-OPENING CASEMENT IN BRICK WALL.

Improved construction, arrangement for 16-inch brick wall. Fig. a, section through window-head. Fig. b, section through window-jamb. Fig. c, section through sill. *F* is the furring to provide air-space to keep out dampness. The interior trim is nailed to the ground (*G*), and the window-frames are securely fastened to wooden lugs built into the brickwork.

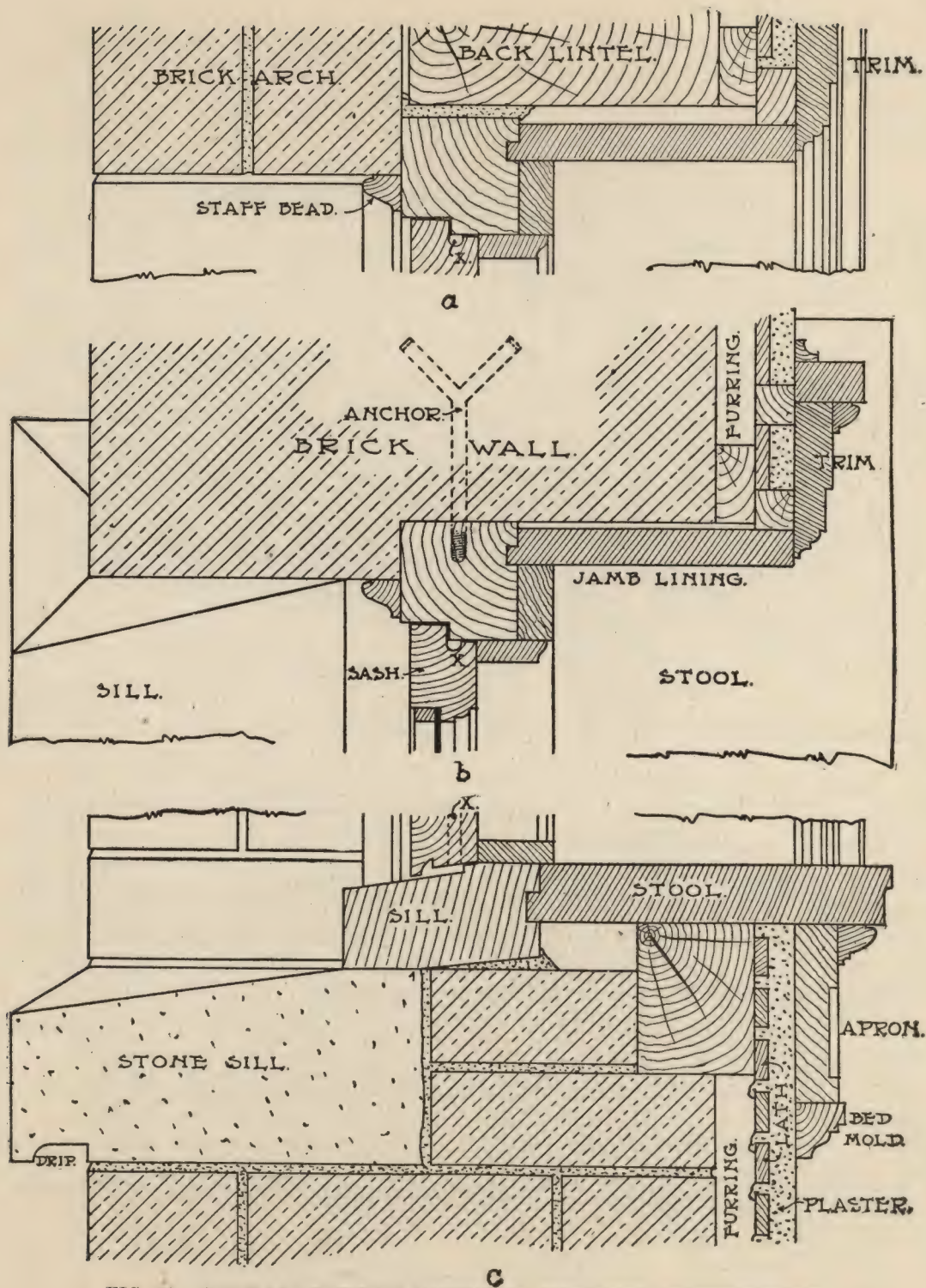


FIG. 78. OUTWARD-OPENING CASEMENT, IMPROVED CONSTRUCTION.

Arrangement for 16-inch brick wall. Fig. a, section through window-head. Fig. b, section through jamb. Note how window-frames are anchored tightly to the masonry, sitting in a recessed space and with joint covered with staff bead. Fig. c, section through sill. X indicates channel to carry away any water which may beat in between jamb and sash.

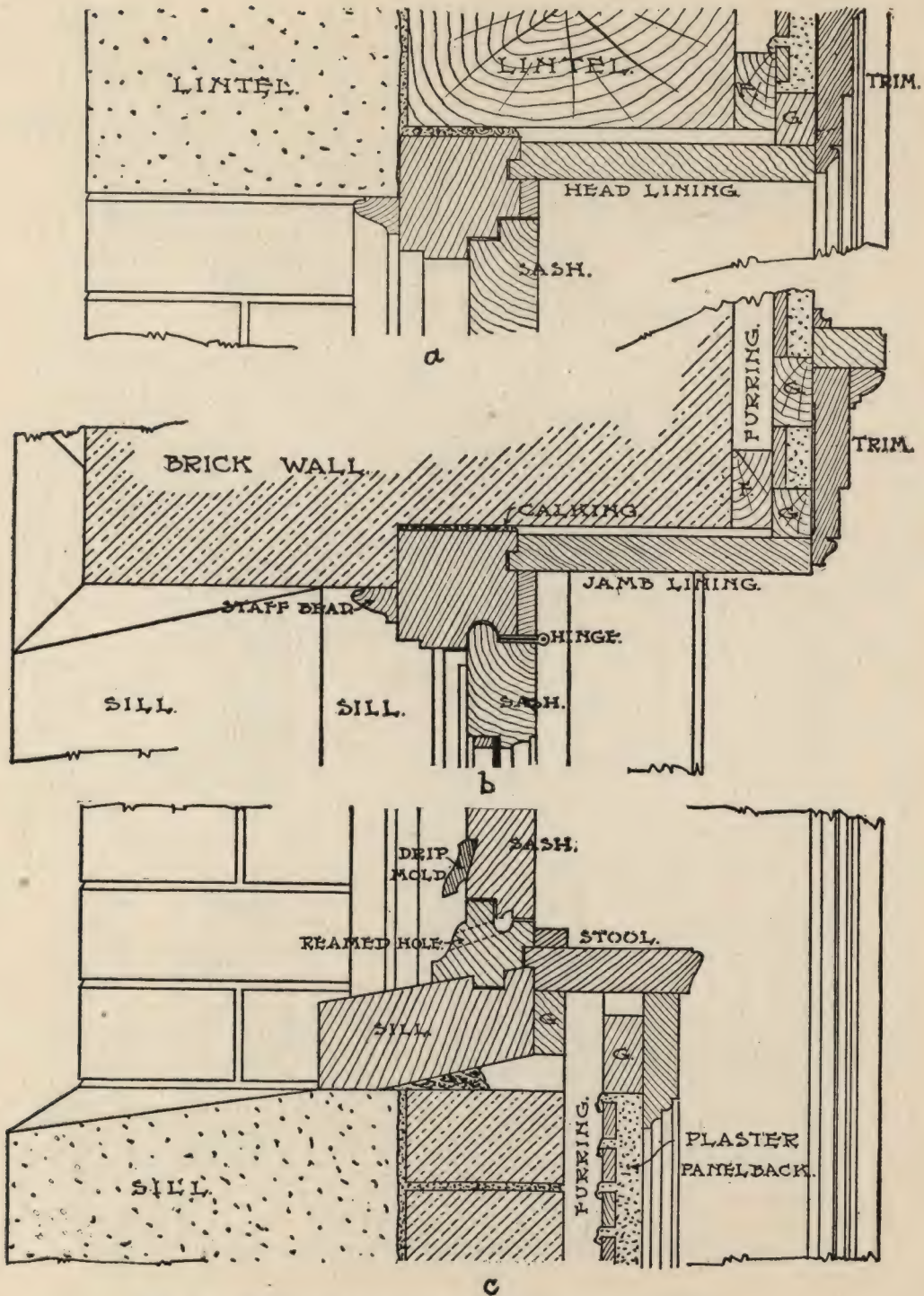


FIG. 79. STORM-PROOF INWARD-OPENING CASEMENT.

Arrangement in brick wall. Details of a very successful method of constructing inward-opening casement windows so as to be proof against wind and rain. The jamb of the frame is set in a rabbet in the masonry wall, and has a semicircular groove cut in its outer edge for a corresponding semicircular tongue on the stile of the sash. The sash tongue fits exactly into this groove, and makes a perfectly water-tight joint. Fig. a, section through window-head. Fig. b, section through jamb. Fig. c, section through window-sill.

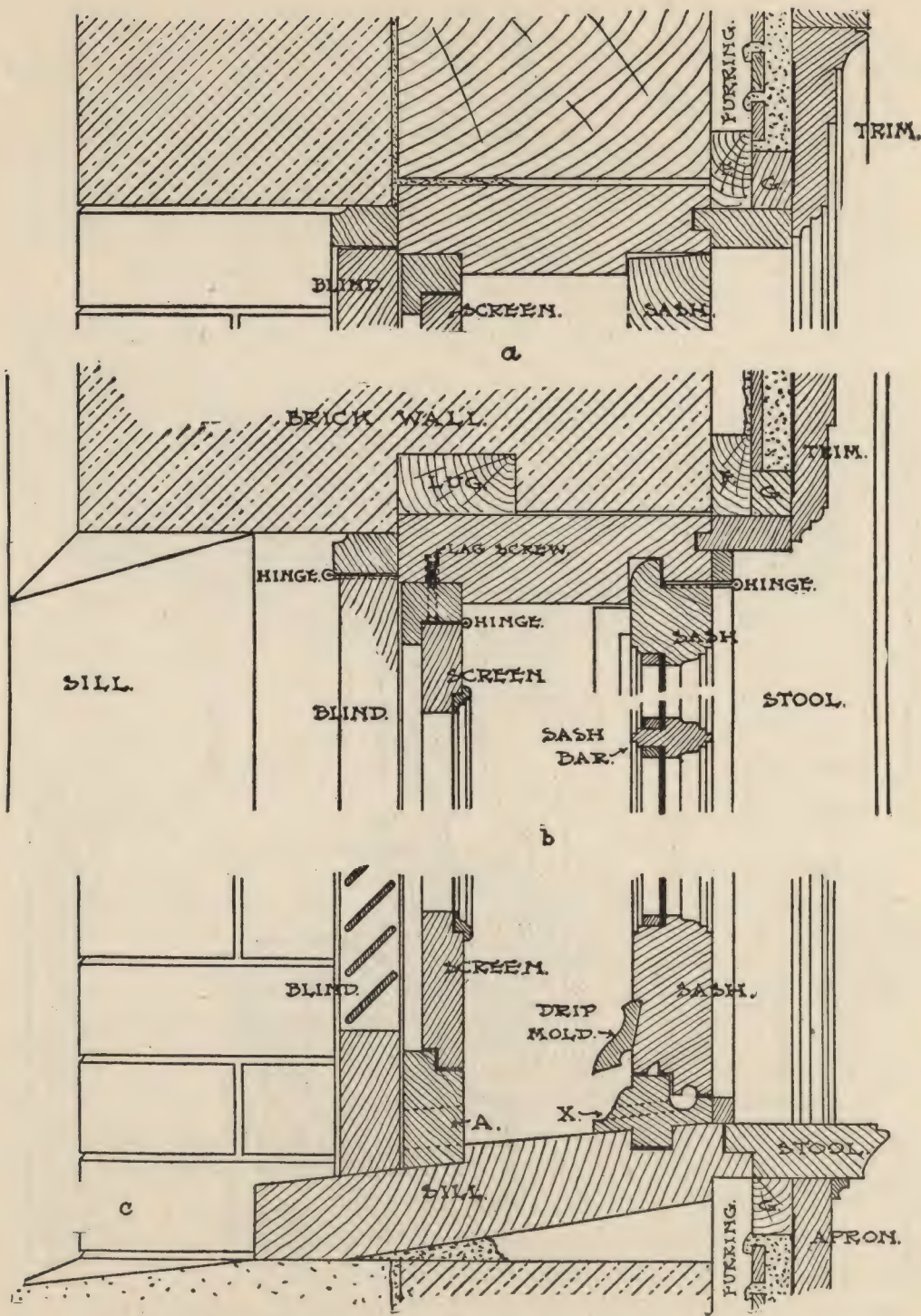


FIG. 80. INWARD-OPENING CASEMENT WITH OUTSIDE SCREENS AND BLINDS.

Construction in brick wall. Fig. a is a section through window-head. Fig. b, section through jamb; note effective waterproof joint between casement and jamb. The screen is hinged to swing in same as casement. The blind swings out, and is so arranged that storm sash can be hung in its place during cold weather. Fig. c, section through sill, showing arrangement to insure water-tightness. Note drip mold and double-rabbeted chambers to lead off moisture that might beat in.

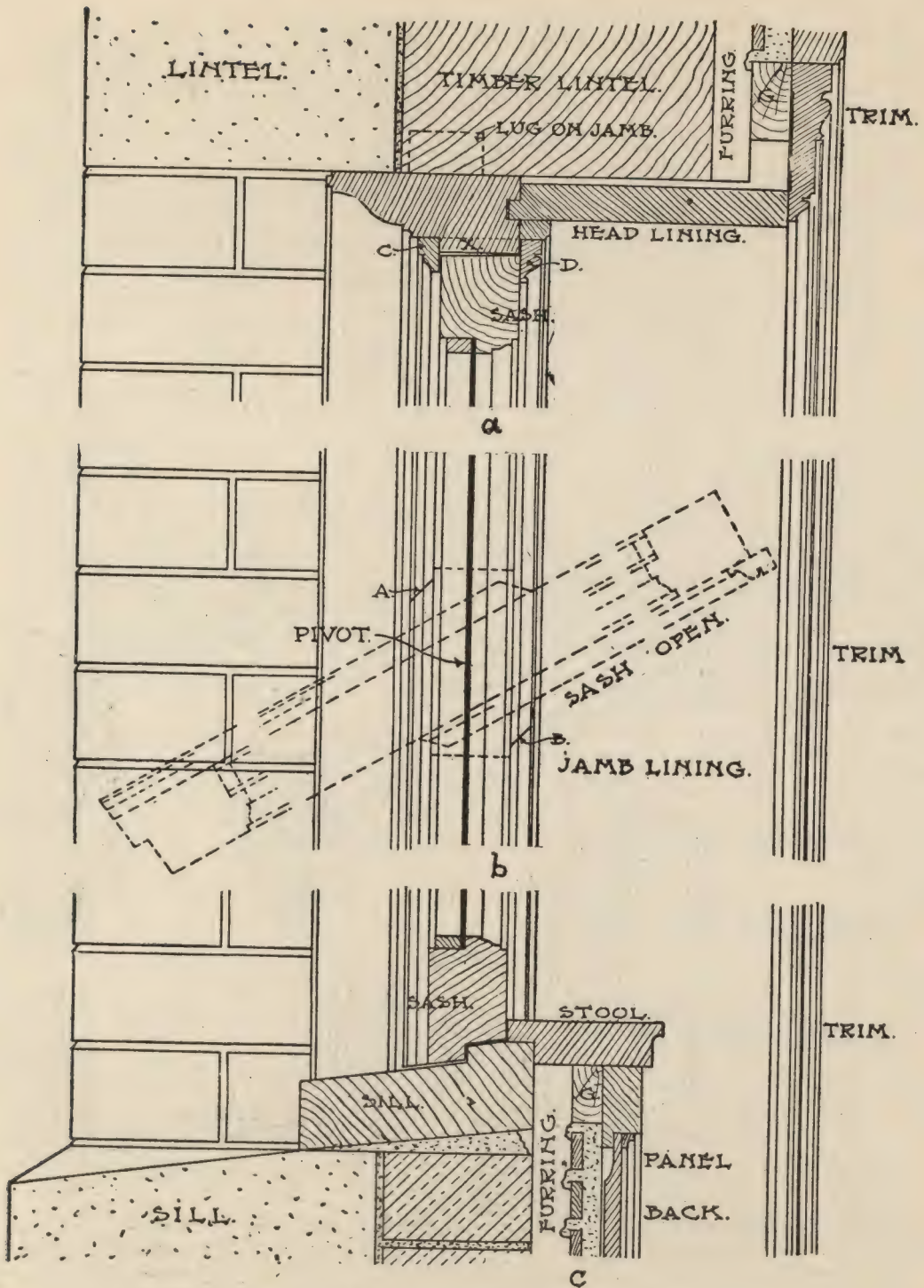


FIG. 81. HORIZONTALLY PIVOTED CASEMENT WINDOW.

Construction in 16-inch brick wall. Pivoted casements should not be used in locations exposed to severe driving rainstorms, as it is practically impossible to make them waterproof at the pivots. At *a* is given a section through window-head; at *b*, vertical section taken through the window at the axis of the sash, showing the window closed by means of the solid lines, and open by means of the dotted lines; at *c*, vertical section through sill.

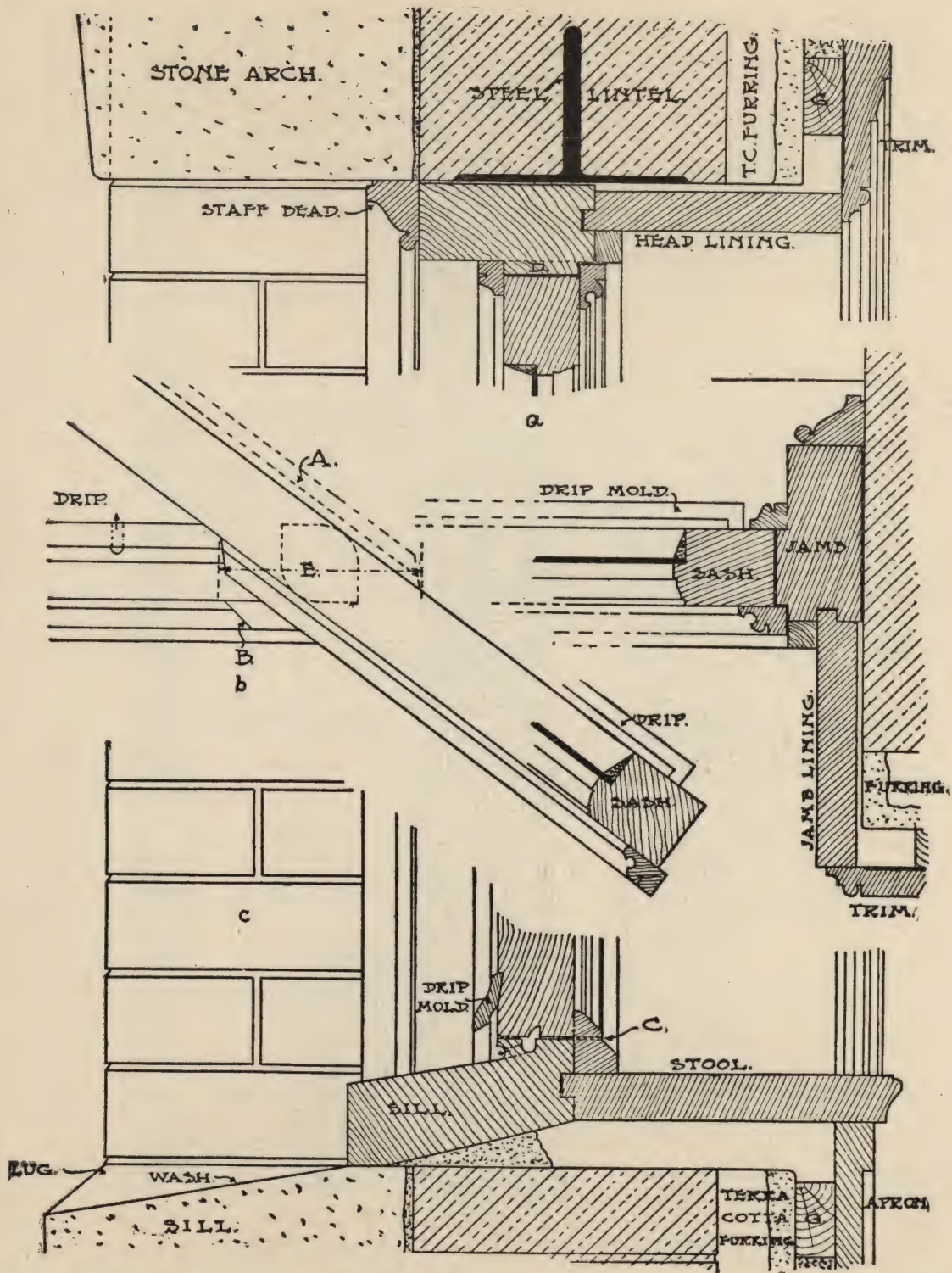


FIG. 82. VERTICALLY PIVOTED CASEMENT WINDOW. CONSTRUCTION IN 16-INCH BRICK WALL.

It is difficult to make this type of window weather-tight, especially for windows in exposed positions. At a is given a section through window-head; at b, a horizontal section through the window, showing the position of the sash, both when open and when closed; at c, vertical section showing the construction at the window-sill.

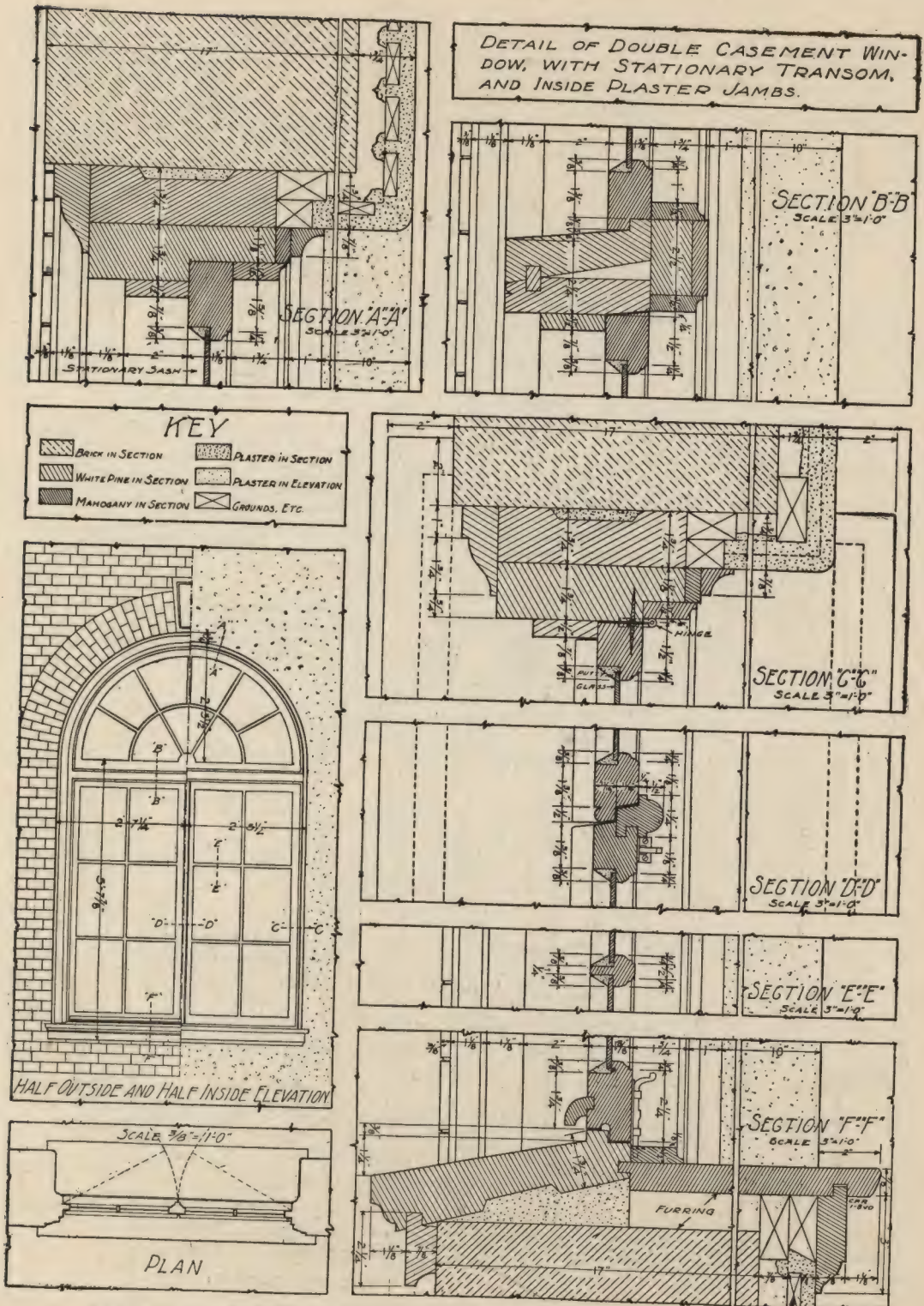


FIG. 83. DOUBLE CASEMENT WINDOW WITH STATIONARY TRANSOM.

Inward-opening casement window with inside jambs plastered. A method desirable in public or semi-public buildings, as it eliminates nearly all the inside finish. Windows of this kind may be used equally as well with a square top transom, or with no transom at all.

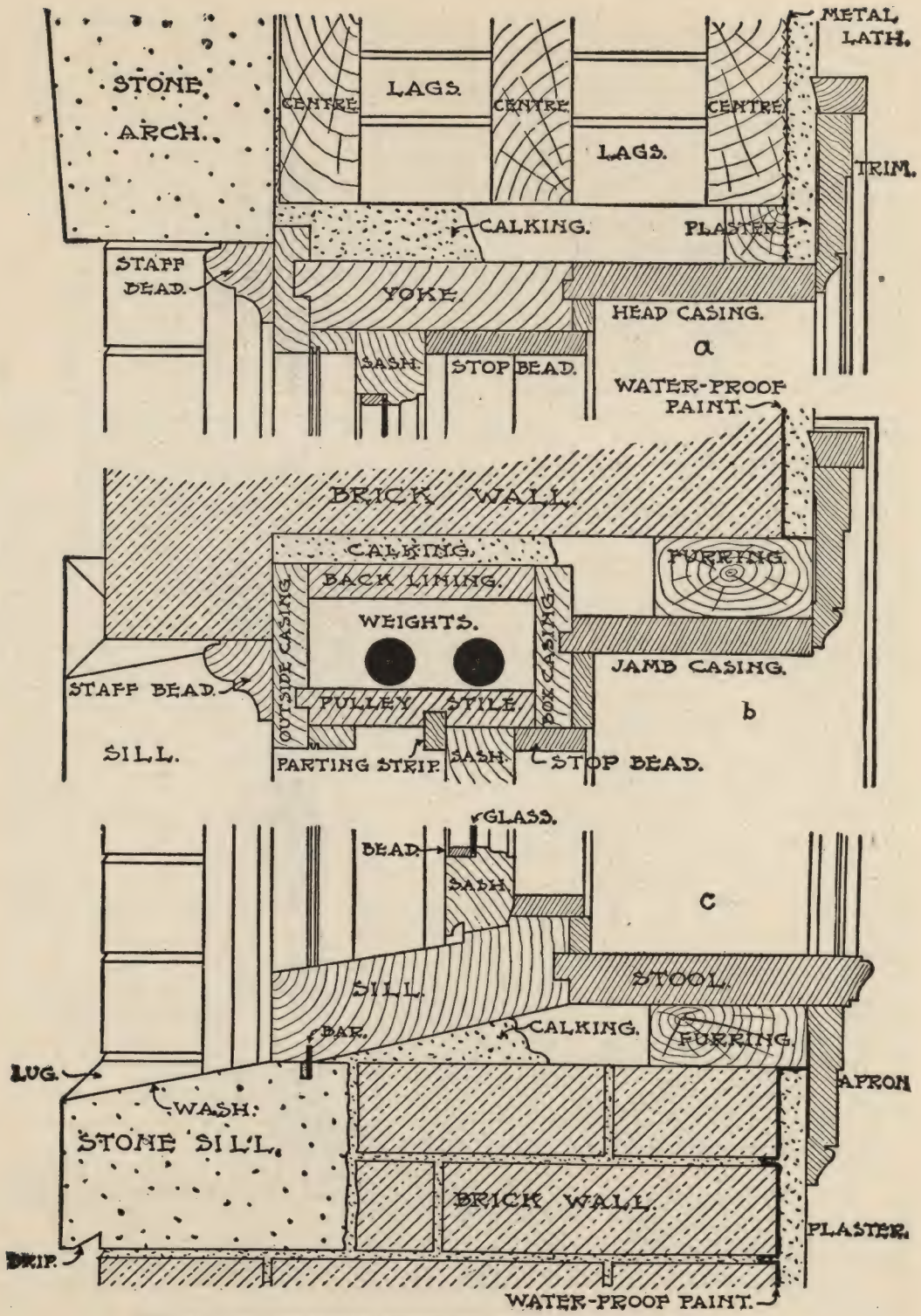


FIG. 84. DOUBLE-HUNG WINDOW IN 18-INCH BRICK WALL.

At a is given section through window-head; at b, section through window-jamb; at c, section through window-sill. Note that furring and lathing of inside walls are omitted, and the plaster applied directly to the brickwork. When this is done, the wall should be thoroughly coated with a waterproofing coat, so as to make it impervious to moisture, which would discolor the finish plaster.

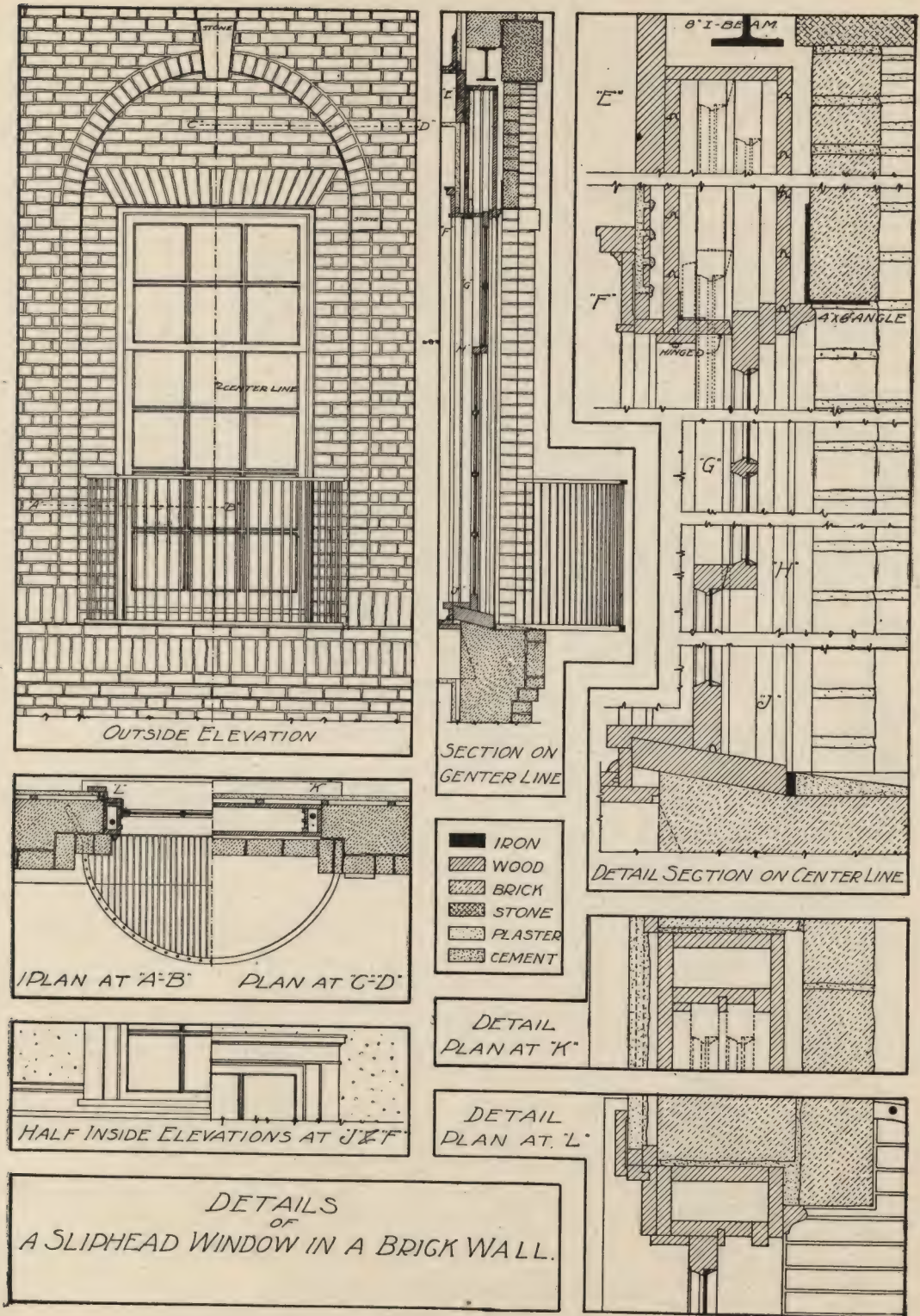


FIG. 85. SLIPHEAD WINDOW IN A BRICK WALL.

This window is popular, especially in the South, for Colonial residences both brick and frame. Attention is called to the hinged head, which is lifted by the sash when raised, and which falls again into position by its own weight as soon as the sash is lowered.

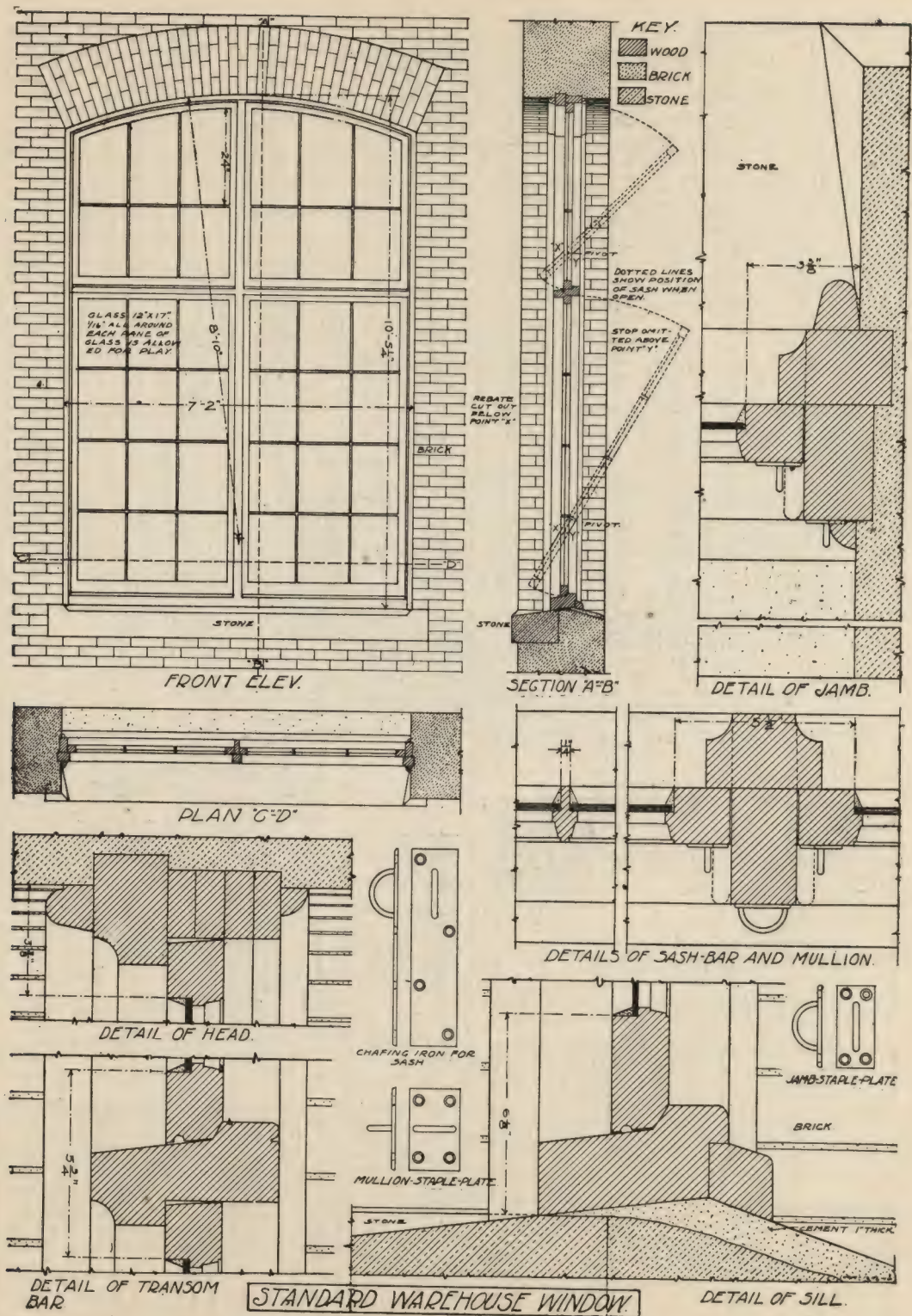


FIG. 86. STANDARD WAREHOUSE WINDOW CONSTRUCTION.

Complete details for double-pivoted windows (wood frames) suitable for mills, factories, and warehouses. The arched window-heads should be made of small pieces of wood glued together and sawed to fit the curve. The interior jambs are of rounded corner bricks.

BRICK FIREPLACES

The introduction of hot-air, steam, and hot-water heating systems for a time threatened the fireplace with extinction. A fireplace however, has always been a domestic altar of content. Man is always at heart a fire-worshiper, and modern buildings have increasingly generous provision for the wood, coal, or gas-log fireplace. As will be seen from the illustrations, brick fireplaces of great beauty of de-

In construction, the hearth is first leveled with brick or concrete, and the hearth and "under-fire" are laid. The metal frame for the opening is then placed, and the lining and backing for the tile facing are made. The tile facing is then laid. Glazed tile, the most beautiful productions of the American potter, are generally used for facings and hearth; and they are set in rich Portland cement mortar.

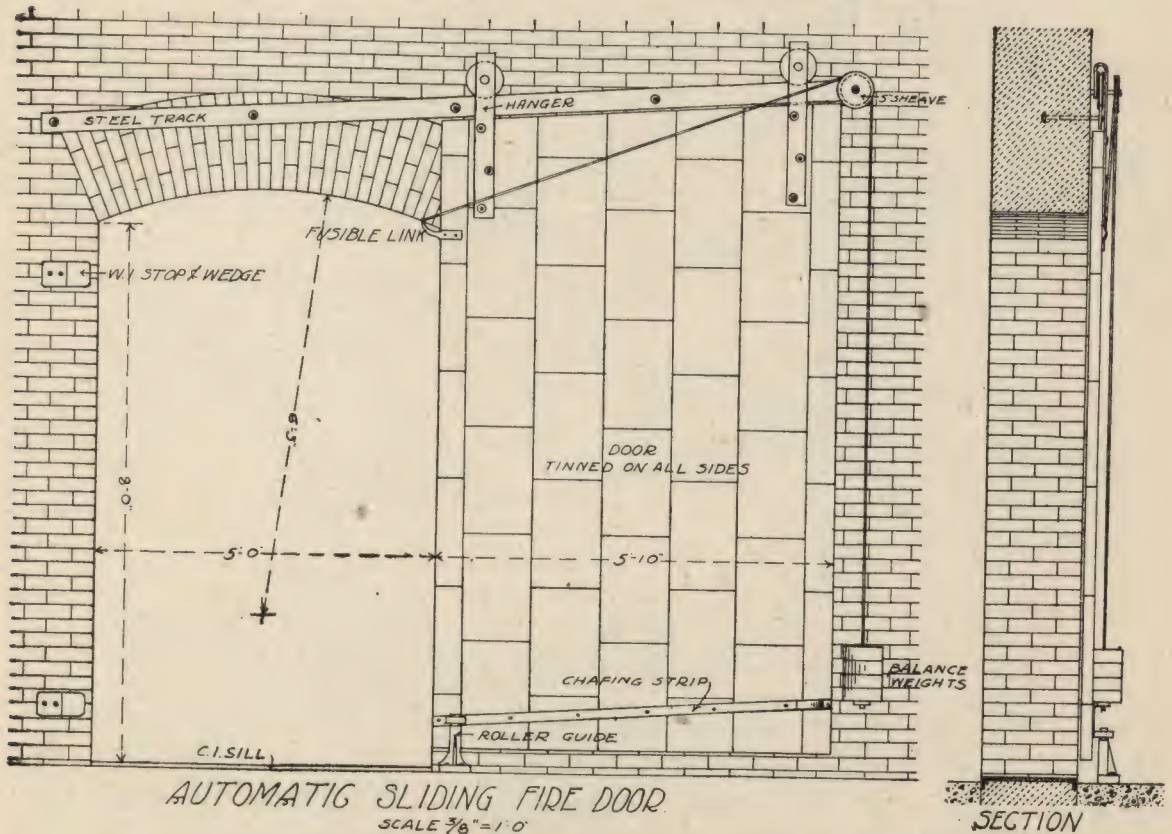


FIG. 87. FIRE-RESISTING WAREHOUSE DOOR.

The arrangement here shown provides for automatic closing of the door in case of fire. The wrought-iron stop and wedge insures tight shutting of the door.

sign are offered to the home-builder, and the purchaser is able to select from a great variety of color combinations. Most of these fireplaces are constructed with firebrick linings, tile facings, and hearths.

A bevel of about three inches to the foot should be given to the side linings; and the back of the fireplace should be inclined inward at the top, as shown in the illustrations, so as to form the throat. This should be about

3 inches in width. Its proper proportioning is important to secure a good draft. The opening should be provided with a damper for draft regulation, and also to close up the opening

are pushed through a small pivotswung ash-dumping plate of cast-iron, saving considerable labor and dirt.

Framing for a Fireplace. In Fig. 88, two flues are shown, one to extend to

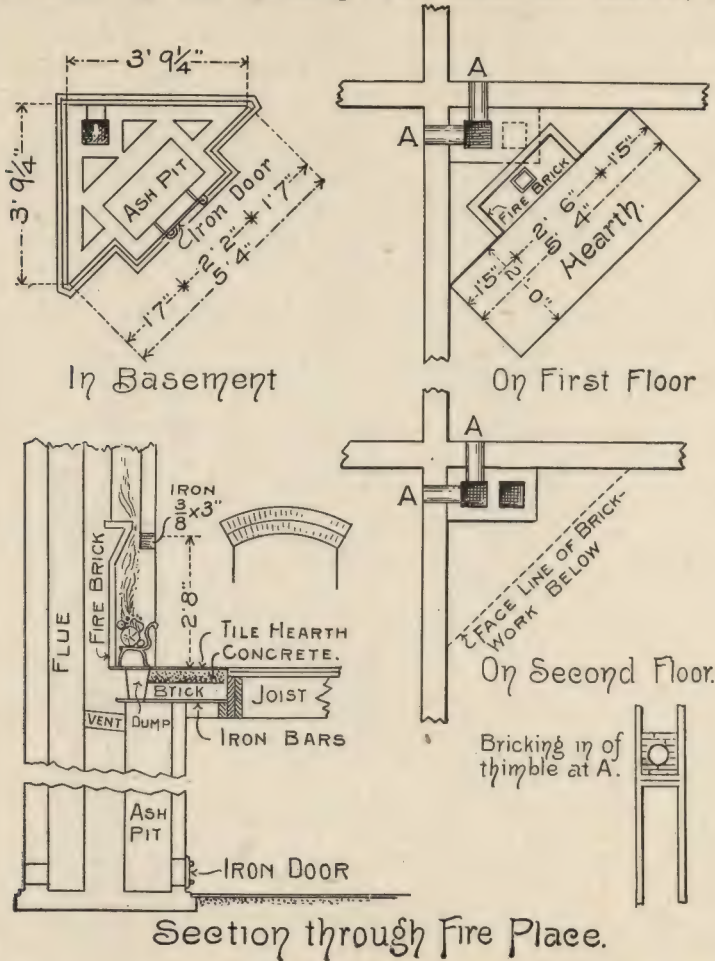


Fig. 88. Arrangement for Fireplace.

when the fire is not needed, and to avoid heat losses.

Where buildings have wooden floors, the hearths of the fireplaces are supported by the trimmer-arch, shown in the illustration. The brick are turned on a wooden center, one end resting on a projecting brick course in the chimney, and the other supported by the joist-header. All fireplaces should be provided with ash-flues leading to an ash-pit in the basement. The ashes

the basement floor, and they are for use of stoves in adjoining rooms. When thimbles are put in to make connection with adjoining rooms, the brickwork should be corbeled out to the full thickness of the wood partition, and a long thimble used to extend through the brickwork, being careful not to let the thimble protrude into the flue space. At sketch A, another way of widening the brickwork at the thimble is shown, which is simply

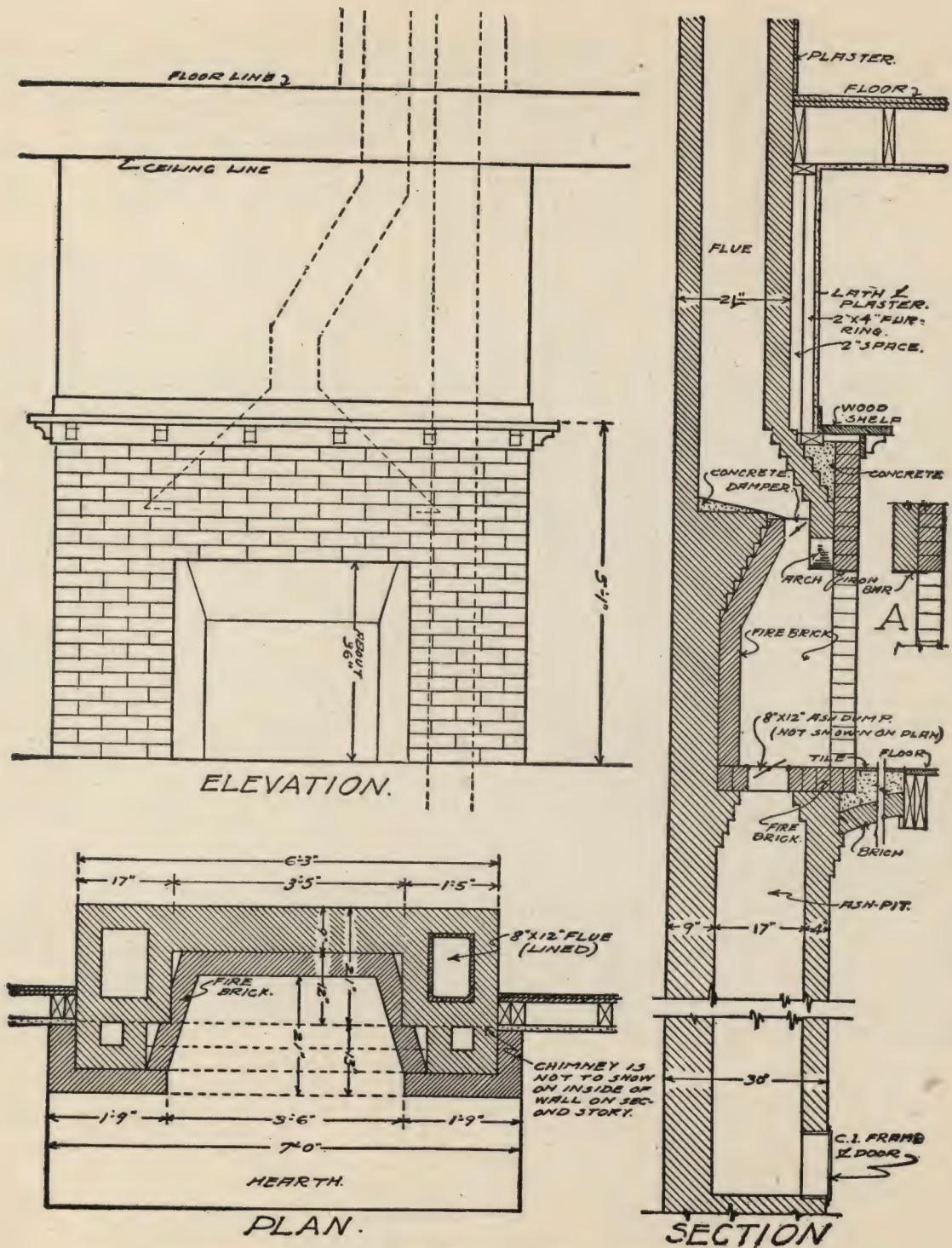


FIG. 89. FIREPLACE CONSTRUCTION.

Design for fireplace with brick mantel; plan and elevation showing best construction and arrangement for an open fireplace that will not smoke. At "A" is shown a form of construction for the arch above the fireplace that is sometimes used; but it cannot be recommended as it is apt to cause the fireplace to smoke. Note air-space between the brick chimney and the wood framing. Dotted lines show the fireplace flue carried across at an easy slant, to be carried up beside the furnace flue. These two flues must on no account be merged into one.

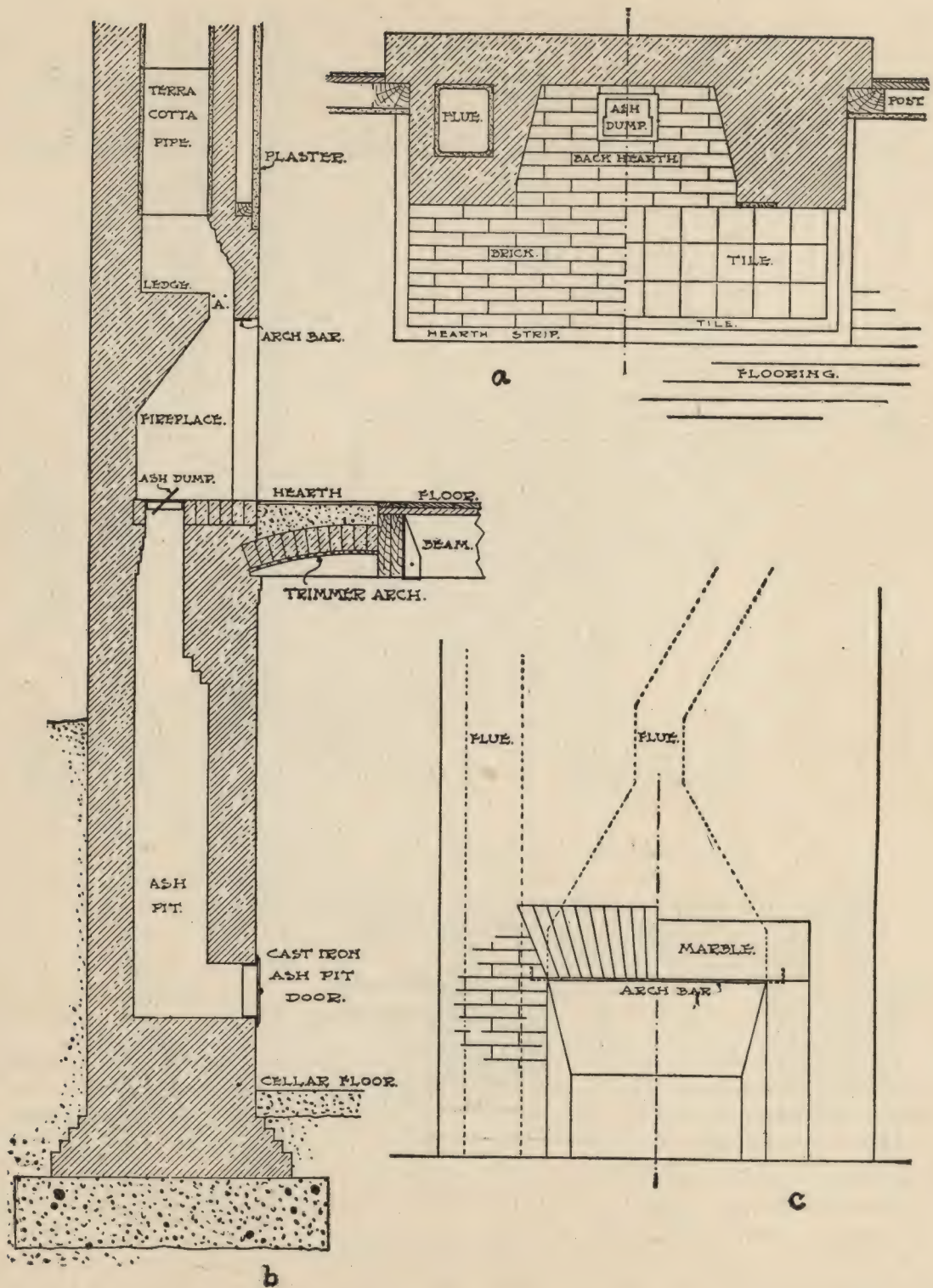


FIG. 90. FIREPLACE CONSTRUCTION, NON-SMOKING.

Fig. a, plan view showing both tile and brick hearth. Fig. b, vertical section through foundation, ash-pit, fireplace, and flue, showing construction and proper design to prevent smoking. Fig. c, front elevation of fireplace, showing arrangement of parts.

to cut in a cross-piece between the studing, and on this build the extra brick-work with all joints well filled with mortar. In all cases the thimbles should be set at the time of building the chimney, being careful that all joints are well filled and tuck-pointed on both

supporting the hearth, use iron bars made of $\frac{1}{2}$ by 2-in. iron; and on this lay brick edgewise, leaving a space of 3 or 4 inches for concrete on which to lay the tile hearth. The fireplace should be lined with firebrick, with the upper part of the brick slanted toward the top



FIG. 91. LIVING ROOM WITH FURNITURE ESPECIALLY DESIGNED TO MATCH THE HOUSE.

sides; and in addition to this, it would be well to plaster on the inside of the flue from bottom to top.

In the illustration we have shown an ash-pit beneath the fireplace, where the ashes may be dumped and taken out later. This pit should have a vent into the flue, so that when the ash dump is opened a downward draught will be created which will prevent the ash dust from flying back into the room. For

of the opening, as shown in the cross-section. The arch in front should be supported on a segment made of $\frac{3}{8}$ by 3-inch wrought iron, set back from the front so that it will not show. If a straight-top opening is desired, then use a 3 by 3-inch angle iron, with the flange on the inside of the brickwork.

The dotted lines show the position of the flue for the fireplace, and will require the opening or throat to draw

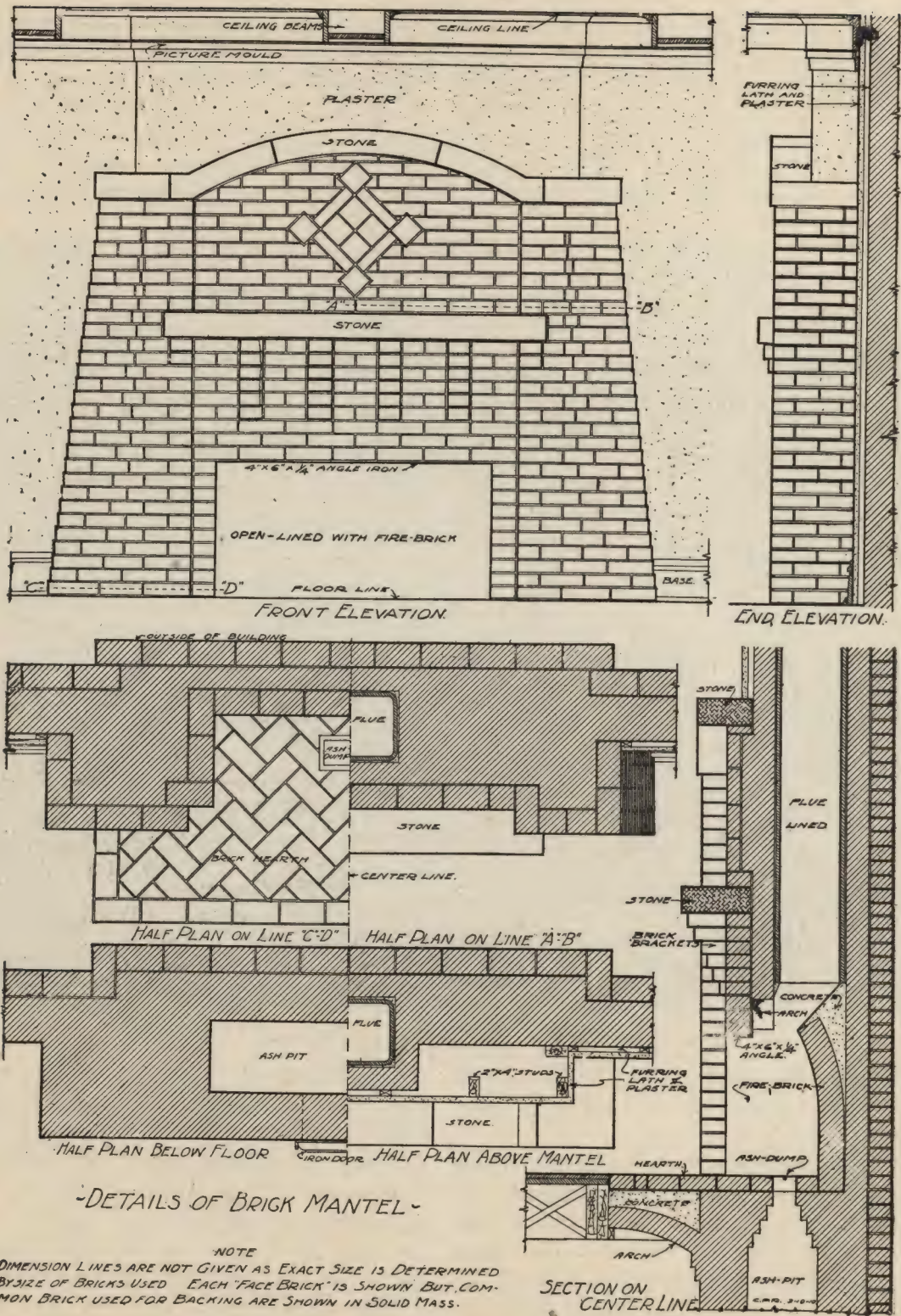


FIG. 92. BRICK MANTEL DESIGN AND DETAILS OF FIREPLACE CONSTRUCTION.

Working drawings showing striking design for a brick mantel, together with details illustrating approved practice in construction of fireplace and chimney.

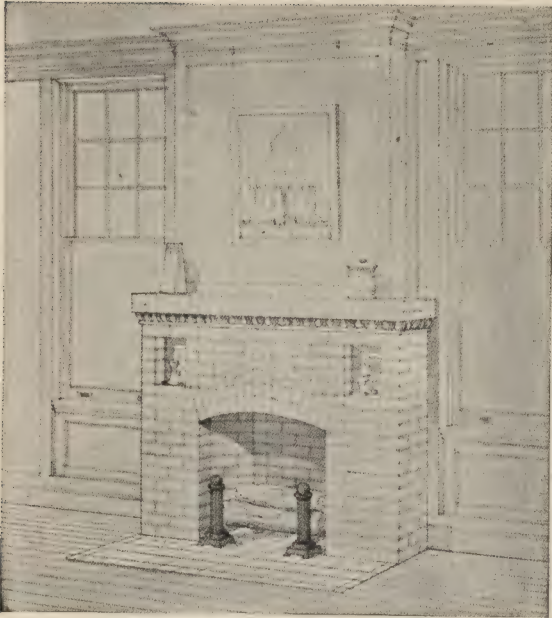


Fig. 93. Brick Mantel Design. Recesses for Bric-a-brac.

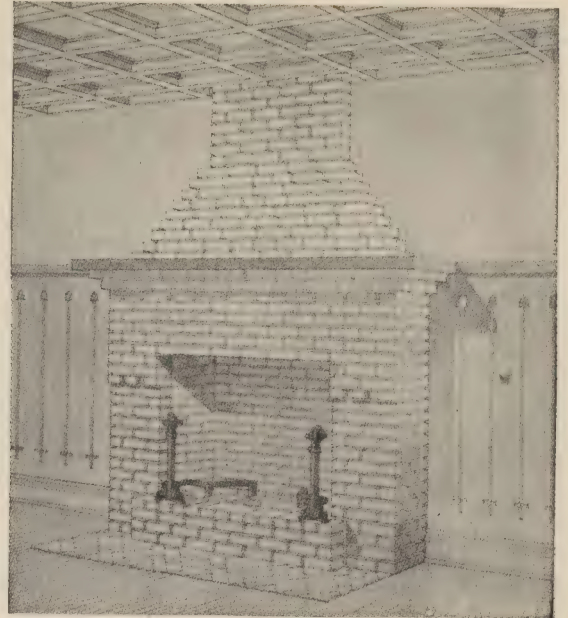


Fig. 95. Brick Mantel Design with Raised Fireplace.

over to it; but it should start straight from the fireplace, and gradually draw over to its position as shown. The face of the brickwork should carry up to the ceiling of the first story; and this gives

ample space to make the proper bend in the flue. The flues should be independent of other openings.

Cast-iron hoods with damper attachment are quite often used to form the



Fig. 94. Brick Mantel Design. Flat Arch.

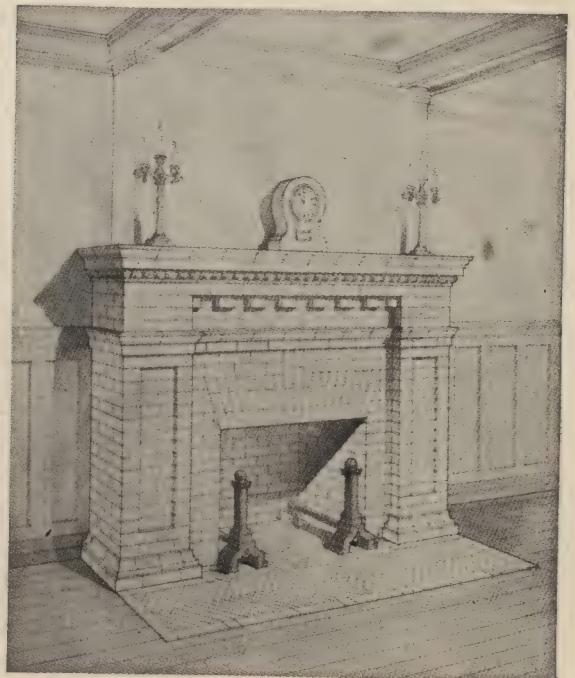


Fig. 96. Brick Mantel Design. Flat Arch.

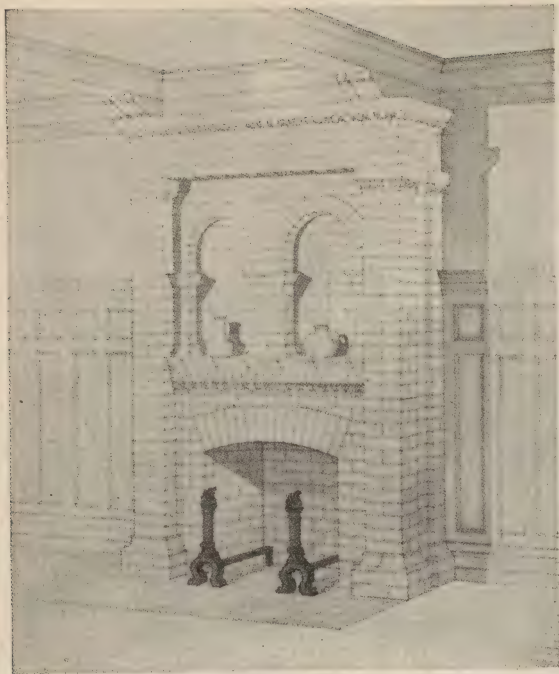


Fig. 97. Brick Mantel Design.

top of open fireplaces, and are set in place at the time of building the chimney. The top should be capped with

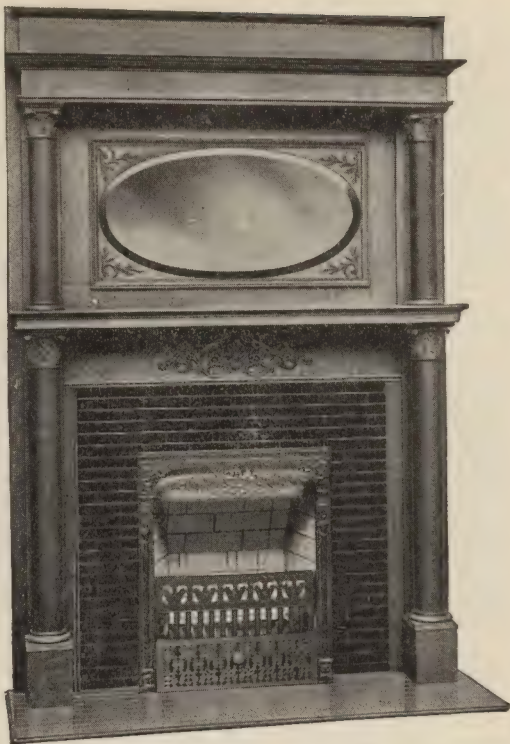


Fig. 99. Popular Style of Mantel, Using Enameled Brick and Tile.

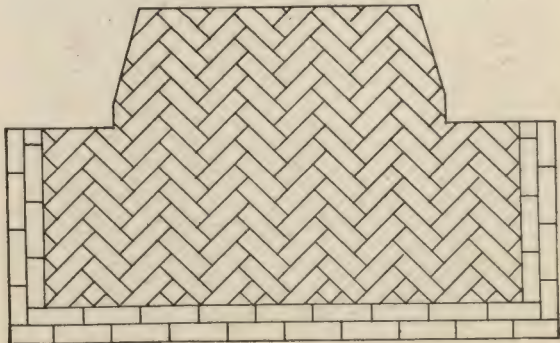
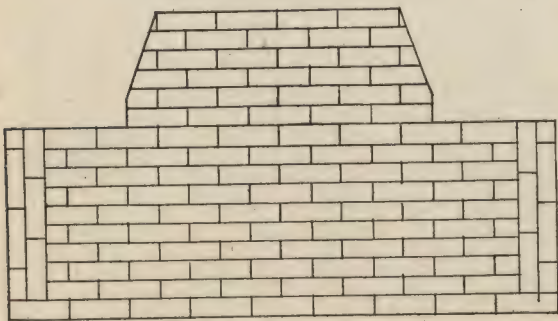
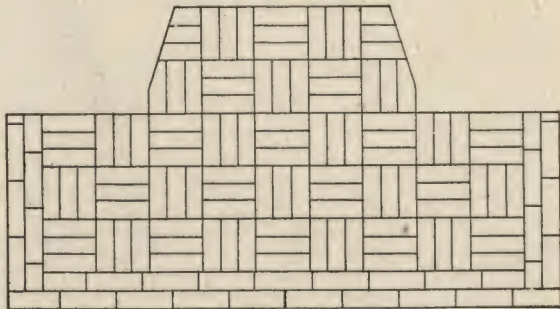
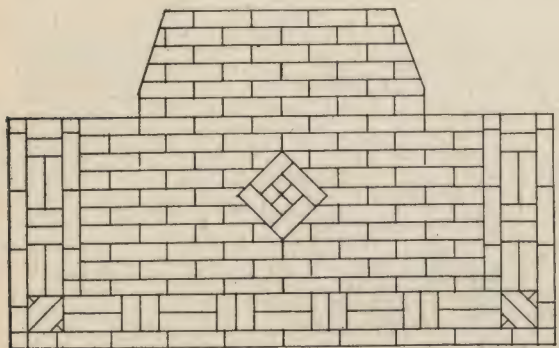


FIG. 98. SUGGESTIONS FOR HEARTH DESIGNS.

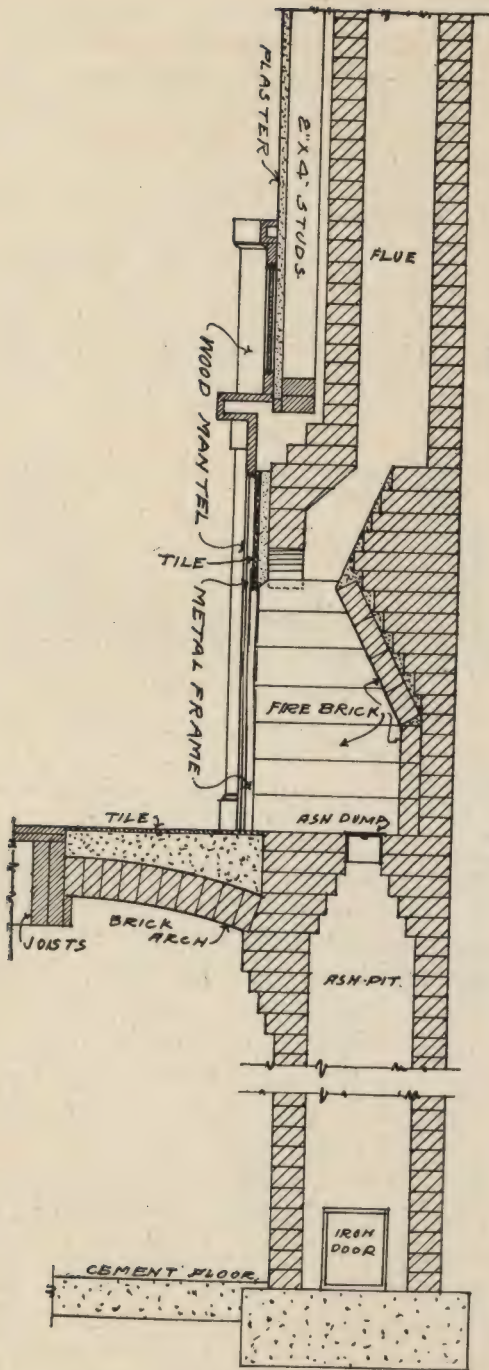


Fig. 100. Details of Flue Construction where Wood Mantel is Used.

Portland cement, or with a 3 or 4-inch flat stone with openings cut to fit the flue openings.

Framing for Heavy Roofing—Tile.

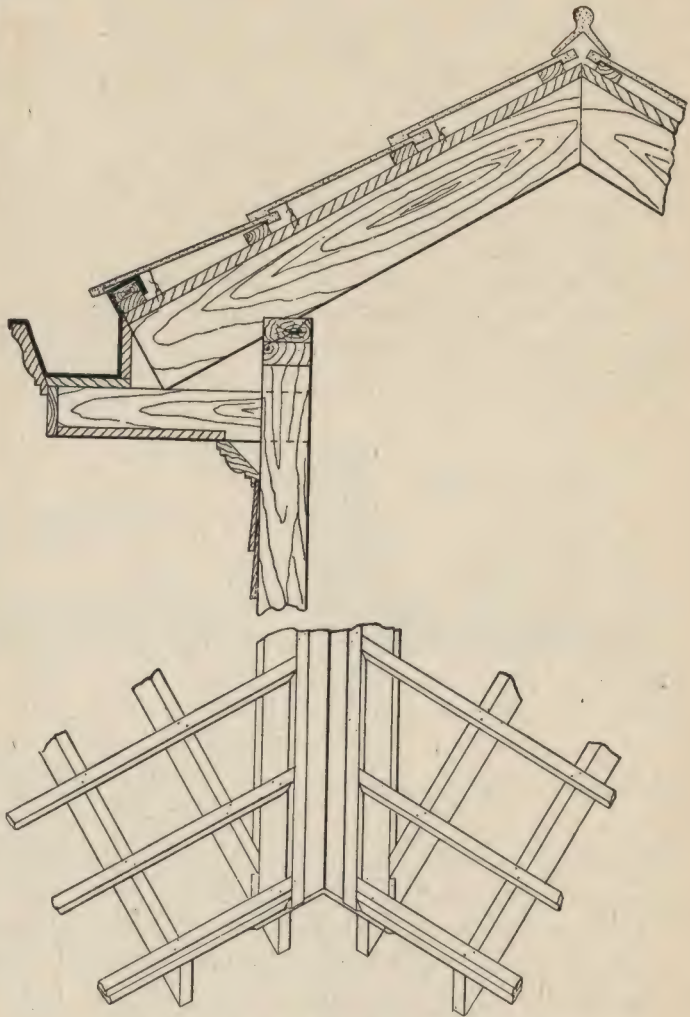


Fig. 101. One Method of Laying Roof Tile. Upper detail shows use of sheathing; lower shows valley prepared for open-roof construction.

There are some special features that should be noted in regard to the proper framing of a tile roof and its preparation to receive roofing tile. Rafters should be at least 2 inches by 6 inches, and 24 inches on centers, or closer, according to length of span. Sheathing should be securely nailed, and should be either of $\frac{7}{8}$ -inch common lumber laid tight and well joined together, or of matched and dressed sheathing securely fastened. The roof pitch may be as low as one-fourth (provided slope is not of extreme length), and from that to the vertical.

Before the tile are laid, the entire roof should be carefully covered with one layer of good roofing felt, laid to lap 2 inches in every course, and to be turned up against the sides of the building at least 4 inches. If the building has a box or cornice gutter, felt should lap over top of metal at least 4 inches, and the same at valleys. After felt is so laid, same should be stripped with good white pine plastering lath, laid parallel, true, and straight, to facing

sheathing under the tile. In that case, there must be a space of 12 inches between the lower edge of the lowest purlin to top edge of the purlin next above it, and thereafter a space of not less than 12 inches nor more than $12\frac{1}{4}$ inches between the top edge of each purlin to the top edge of the purlin next above it. These purlin strips should be $\frac{7}{8}$ inch by 2 inches or over, the bottom strip $1\frac{1}{4}$ inches higher than the strip next above it—that is, $2\frac{3}{8}$

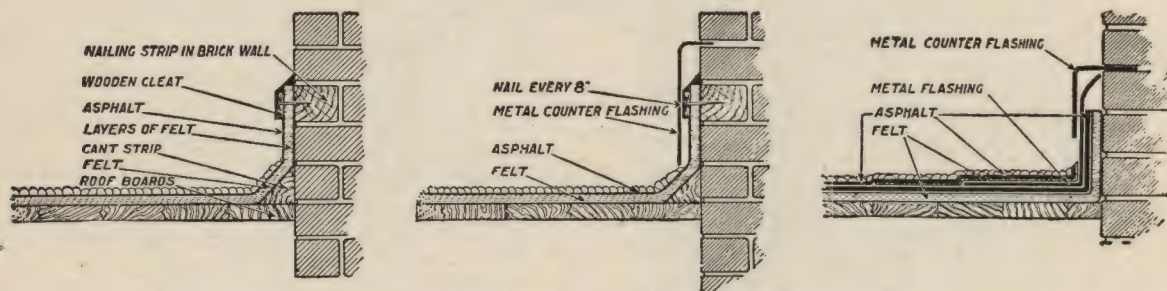


FIG. 102. DETAILS OF FLAT ROOF CONSTRUCTION.

Approved construction at the fire-wall joint for tar and gravel flat roofs. The methods here illustrated vary in cost, ranging from the cheapest (at left) to the most expensive (at right).

board at eaves. The top edge of first line of lath should be 12 inches above the lower edge of facing board or starting strip; and thereafter not less than 12 inches nor more than $12\frac{1}{4}$ inches space allowed from the top edge of each line of lath to the top edge of the next above and parallel. The tiles hook over these strips; and each tile is fastened with a seven-penny galvanized-iron or copper wire nail.

All ridge-boards should extend 3 inches above top of sheathing, and hip boards $2\frac{1}{2}$ inches, and both be of $\frac{7}{8}$ -inch common lumber. Facing board or starting strips at eaves under bottom end of tile, will extend up above the top edge of sheathing $1\frac{5}{8}$ inches. In all cases facing boards at gable ends should be flush with the sheathing.

In some cases an **open** roof construction is used—that is, one with no

inches by $\frac{7}{8}$ inch. In this construction the hip and ridge strips should be the same as if the building were sheathed.

Segmental Arches in Brick Walls. The word "segment" means a portion or part of a circle. In point of fact, any arch struck from one center, and being less than a semicircle, is properly termed "segmental."

The most common use of the segmental arch is perhaps, as a **relieving arch** over the lintel of an opening for a door or window in a brick wall. In such cases, no better proportion can be taken than one-sixth of a circle. There is, however, an important point of construction involved, and one that is often neglected.

Fig. 103 shows two relieving arches, one being laid out in the wrong way, and the other correctly. The first is wrong because, in the case of fire, the

wooden lintel would be consumed, and the thrust of the arch on the burnt end would be bound to cause a failure and endanger the whole of the wall above.

correct method, for it costs no more than the incorrect one; and the advantage of it in case of fire is greatly in its favor.

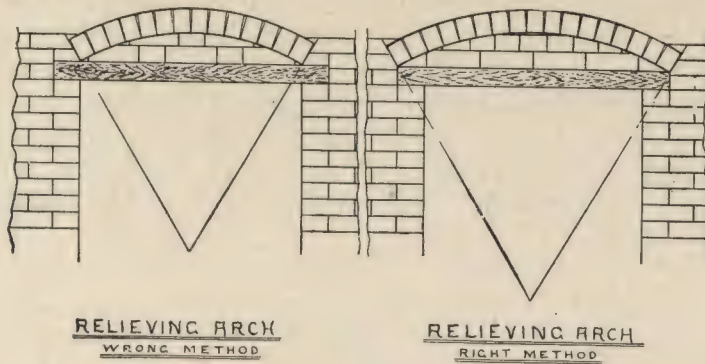


Fig. 103. Segmental Arches in Brick Walls.

A better way is shown. Instead of making the span of the relieving arch equal to the opening between the jambs below, the arch springs from a point over the extreme end of the wooden lin-

Of course, for such arches, no elaborate centering is necessary. The lintel is laid in position; and a piece of $1\frac{1}{2}$ -inch stuff is shaped to the curve of the arch, and laid upon the lintel to form

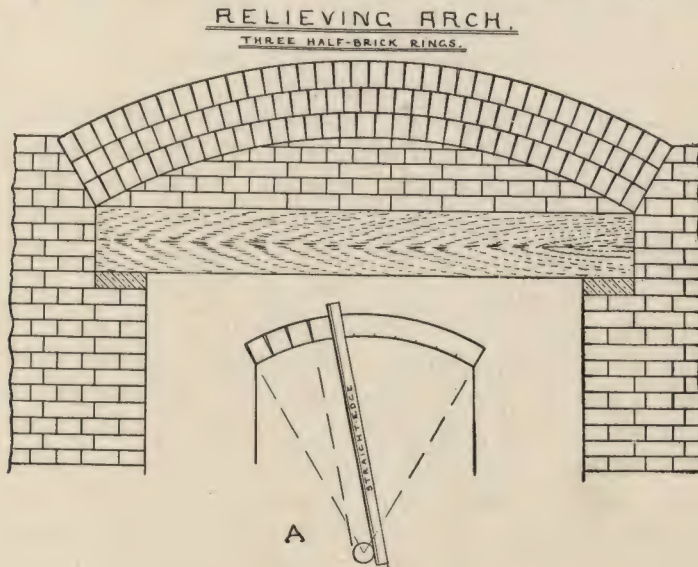


Fig 104. Segmental Arch, and How to Lay It Out.

tel. In case of fire occurring and the lintel being entirely consumed, the arch would be unaffected, and would continue to carry the weight above. Building inspectors and managers should insist on the adoption of this

the centering. The arch is then turned upon this centering, which is removed when the mortar is properly set, the core being then filled in with brickwork.

For openings up to three feet or thereabouts, a relieving arch of a single

ring of half-bricks is all that is required; but for larger openings, several rings may be used.

Fig. 104 shows an arch of three rings, and it will be noticed that each arch is separate and not bonded into its fellows. It will also be noticed that the bricks of these rough relieving arches are not cut taper, and thus the joints are slightly more open on the back of the arch than on the under side. In

and fitting, or perhaps molding, the bricks of which it is to be composed. Brick arches in which the bricks have been specially cut or molded are generally termed **gauged arches**, and are frequently used nowadays.

The **radius** of the arch is scarcely ever given by the architect, the **rise** being almost invariably denoted instead. The writer has before him an elevation of a brick-fronted building with some

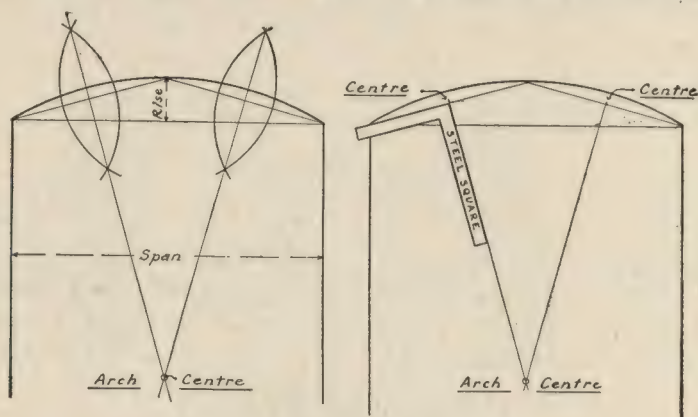


Fig. 105. To Find the Arch Centers.

making drawings of such arches, the draftsman draws a ring around the center from which the arch is struck, the diameter of the ring being the thickness of the brick. This thickness is then stepped off on the under side (soffit) of the arch with a pair of dividers, and the straight edge placed against the ring and one of the divisions on the soffit (see **A**).

How to Lay Out Arches. The chief problems, however, with which the practical layer-out of arches is confronted, arise in connection with the modern use of fine pressed brick for so many first-class structures. For while the mere curve is sufficient for practical purposes in rough relieving arches, the arch made of facing bricks, and forming a feature of some fine front, must be set out exactly for the purpose of cutting

eight or ten openings of varying widths, but the same rise is specified for all the arches over them. This means that the layer-out has to find the centers of the several curves from the given particulars of their rise and span. This he does as shown in Fig. 105, the first being the geometrical method of the drafting room; the second, the practical method of the laying-out shop. In both cases, the center from which the arch is struck is found at the intersection of the lines drawn from the center of each half of the arch.

As the bricks in gauged arches are used full length, the thickness of the brick is marked off around the back of the arch, and the joints drawn to the center, as in Fig. 108, at left. The joints are very fine, being usually specified to be not more than $\frac{1}{8}$ inch, the mortar be-

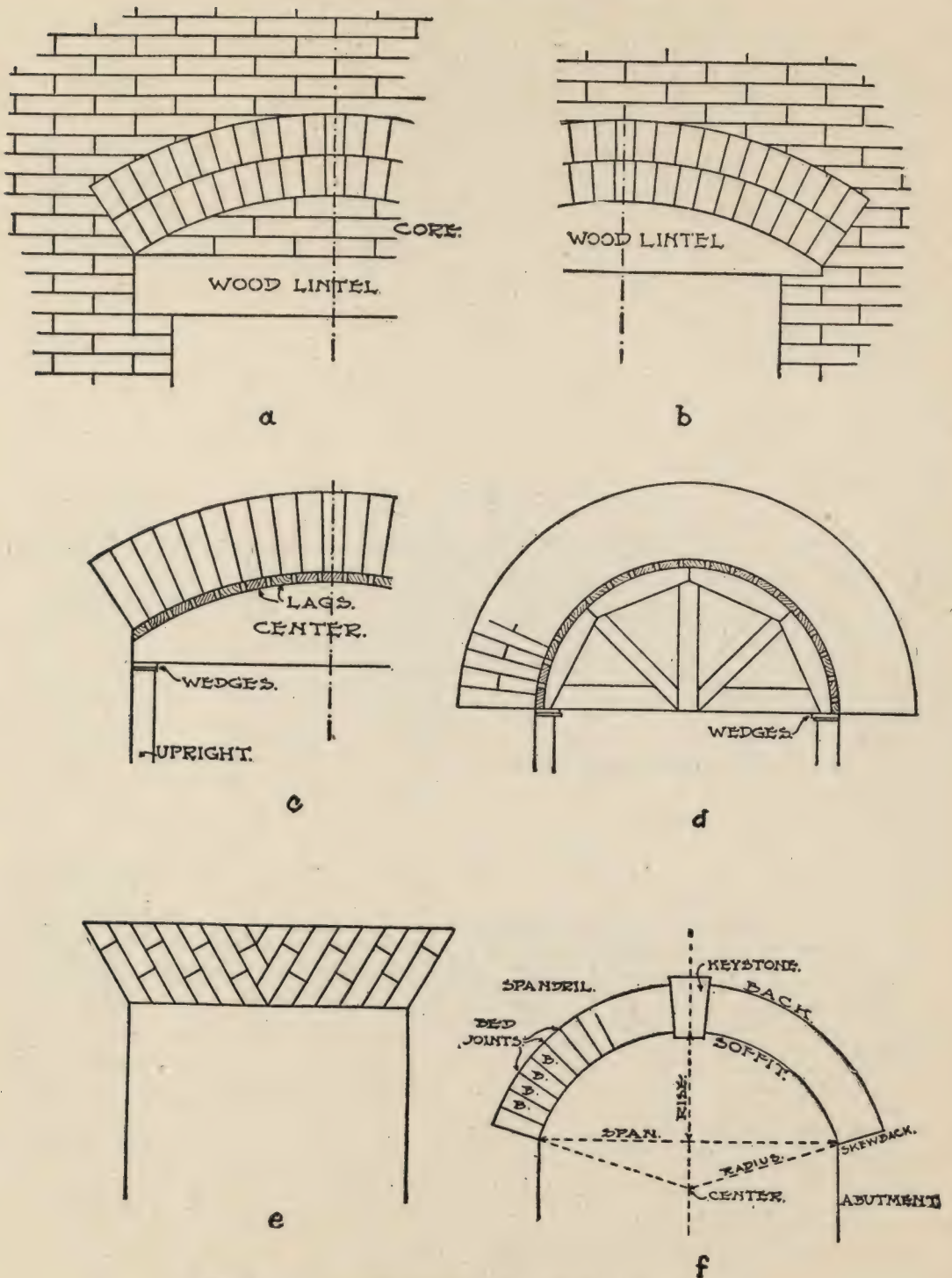


FIG. 106. CONSTRUCTION OF BRICK ARCHES.

Figs. a and b interior views of flat arches. The main weight of the wall is carried by the concealed wooden lintels and the rough brick relieving or discharging arch above. Figs. c and d show wooden falsework used to support the bricks of an arch while the arch is being built. Fig. e, Dutch arch, ornamental though weak in construction and suitable only for openings of narrow span. Bricks have to be specially cut to shape. Fig. f is a diagram giving the proper names for various parts of an arch.

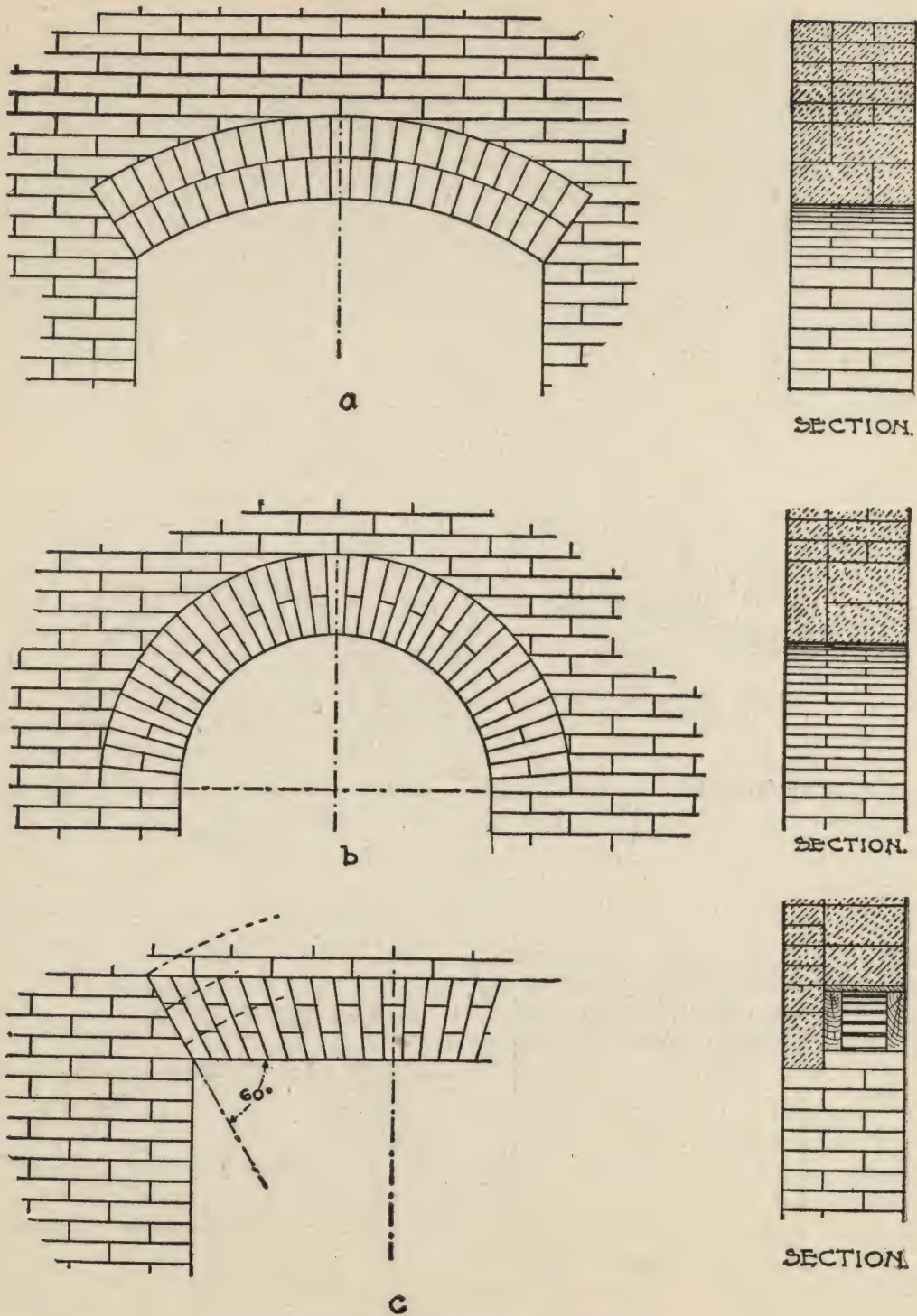


FIG. 107. CONSTRUCTION OF BRICK ARCHES.

Fig. a, segmental arch, with two-rowlock arch used in common work. The bricks are laid on edge in two concentric rings extending through the wall. Fig. b, segmental arch formed of ordinary bricks rubbed or cut to the required shape, and forming a perfect bond. Fig. c, flat arch composed of bricks rubbed or cut to the required shape. Arches of this form should have a rise, or camber, equal to about one-eighth of an inch for every foot of span, in order to prevent sagging. A concealed wooden lintel or arched framework bears most of the weight above.

ing either of fine cement or lime putty.

In Europe, special bricks are made for such arches, and are known as **red rubbers**. When new, they are quite

membered, though, in building such arches — namely, that a **perfectly straight soffit** will always appear to be sagging. The remedy for this is to

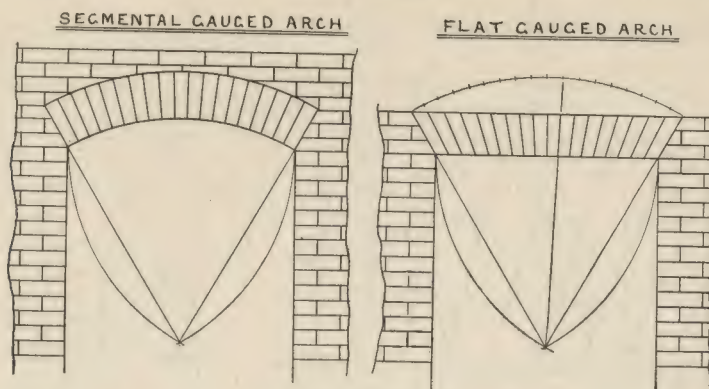


Fig. 108. Brick Arches.

soft, and can be sawed with a handsaw, and rubbed upon a block with sand and water to form close joints. After being exposed to the air for a time, the surface of these bricks becomes exceedingly hard and impervious to the action of the weather. For the red brick dwellings of "Queen Anne" and "Colonial" style, now so much in vogue again, such bricks are exceedingly useful. Not only can they be cut for the characteristic flat arches of these styles, but moldings can be worked on the angles, and panels formed to relieve broad surfaces of wall. More often, however, bricks for gauged arches are specially molded to the builder's drawings by the makers of the face bricks, with fairly good results in the finished work.

The flat arch just referred to is also much used in brick fronts in city buildings, and is drawn as shown in Fig. 108, at right. It presents no difficulty to the layer-out, the joints being found by making a curve above the arch and stepping off the thickness of the bricks upon it.

There is one important point to be re-

allow a trifling rise—say $\frac{1}{2}$ inch for every three feet of span—which will be sufficient to make the under side of a flat arch look straight. This can be easily done on the job by laying two strips tapering from nothing at the ends to the required allowance at the middle, upon the support or centering

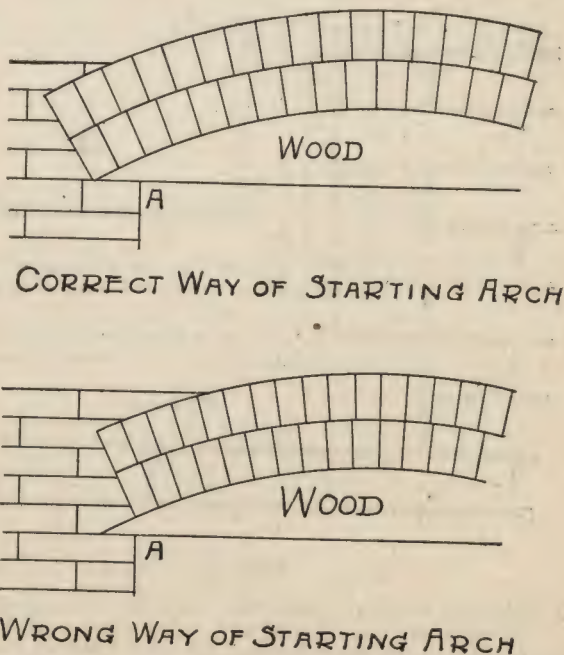


Fig. 109. Correct and Incorrect Methods of Brick Arch Construction.

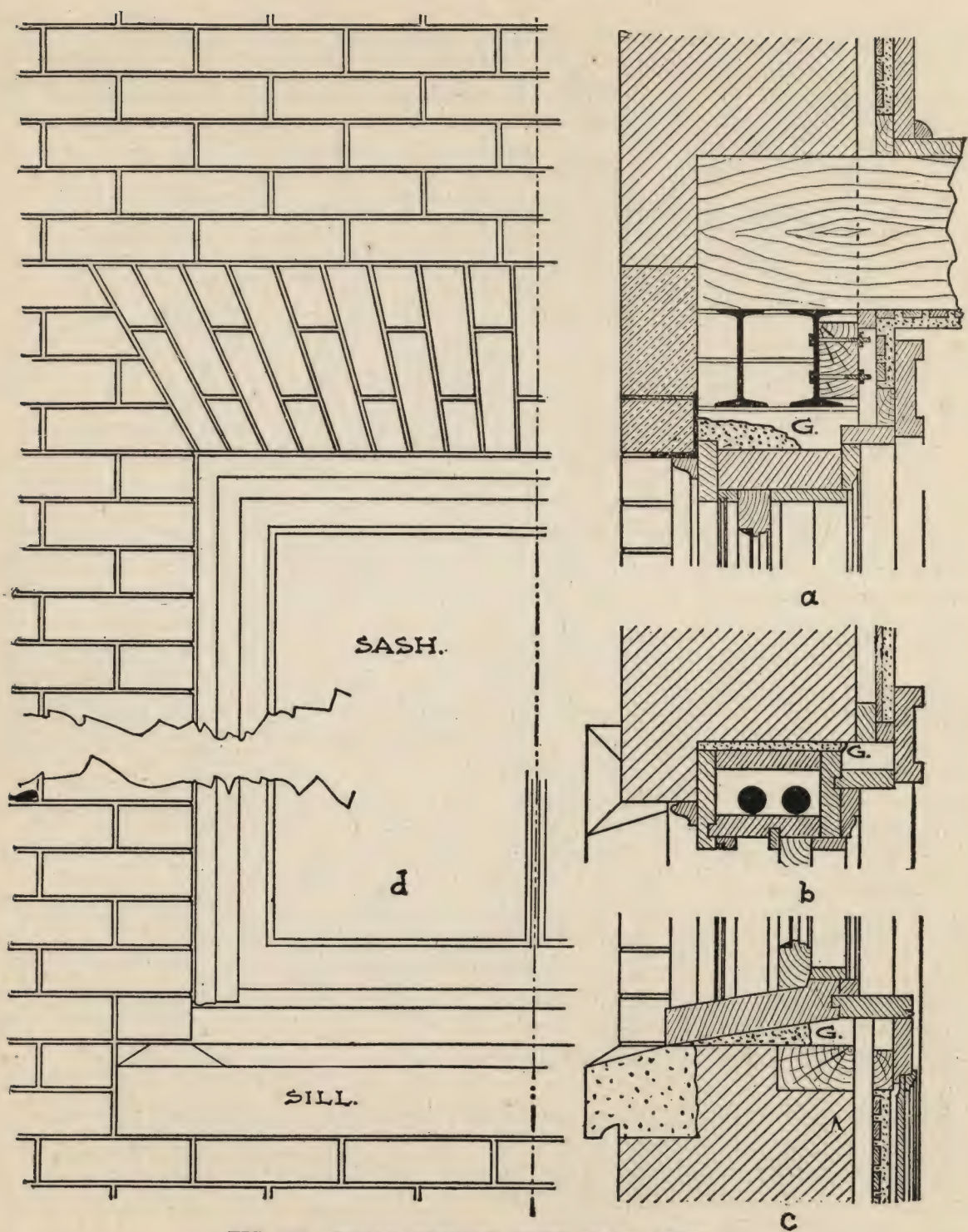


FIG. 110. BROAD WINDOW WITH FLAT ARCH.

Double-hung window construction in 13-inch brick wall, the weight above the window opening, including floor-joists, being supported by two steel I-beams. Such I-beams are necessary when there is not sufficient space between the window-head and the under side of the floor-joists to turn a brick relieving arch on top of a timber lintel. Fig. a, section through window-head, showing angle-iron supporting flat brick arch, and I-beams supporting floor-joists. Fig. b, section through jamb. Fig. c, section through sill. Fig. d, exterior view of window.

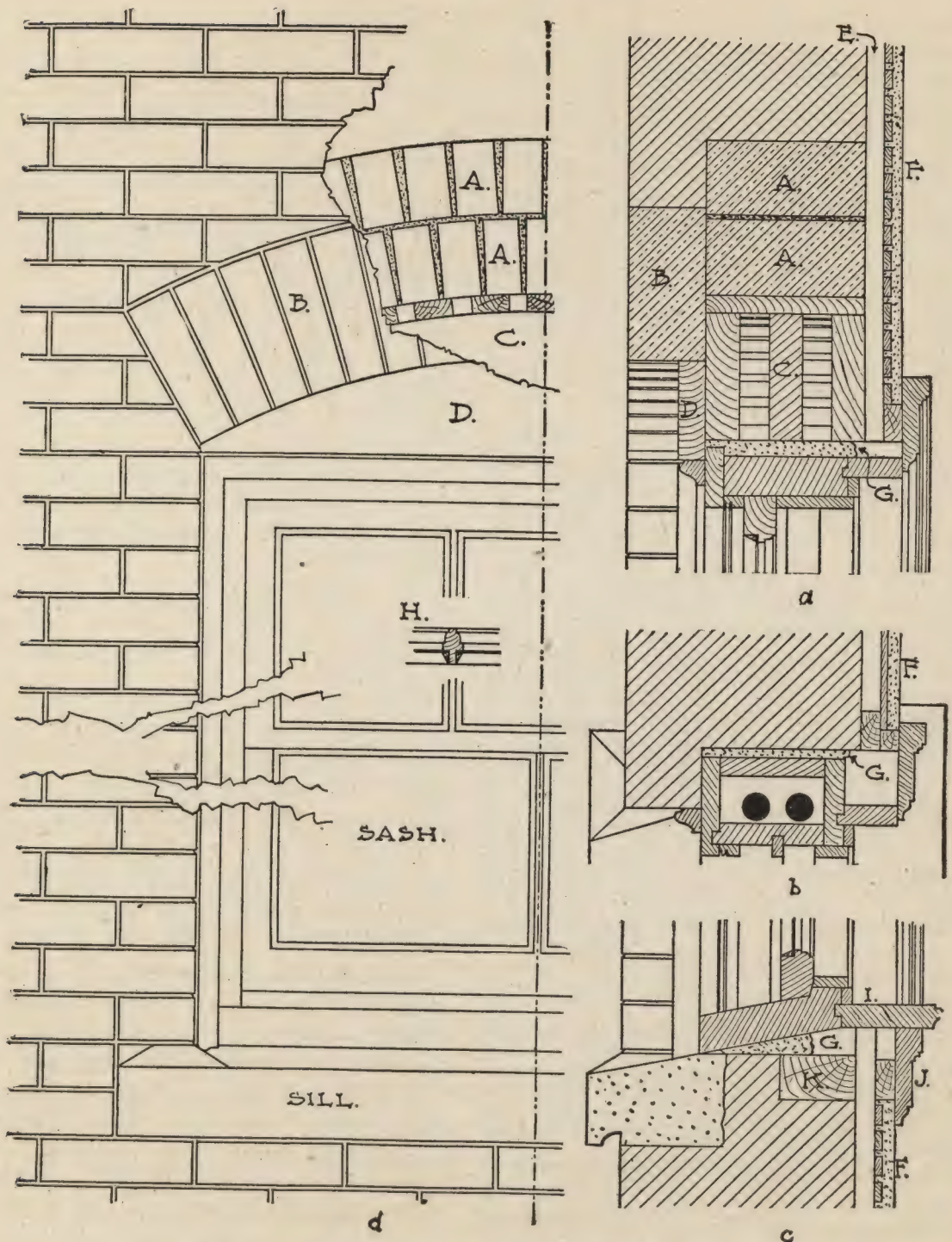


FIG. 111. BROAD WINDOW WITH SEGMENTAL HEAD.

Double-hung window construction in 13-inch brick wall, the window finished with an arch on the outside and a square head on the inside. Fig. a, section through window-head, at center line. The opening is spanned on the outside by the segmental arch (B) of face-brick. The inner 8 inches are supported by a permanent wood center (C), and the two-rowlock relieving arch (AA). E indicates the furring which should be used to prevent dampness. Fig. b, section through jamb, showing space (G) filled with mortar or hand-caked with oakum. Fig. c, section through window-sill. K is a 2 by 4 nailing strip. Fig. d, exterior elevation of the window. Note the piece D put in as a finish to cover the rough wood center C.

upon which the mason forms his arch.

Of course, flat arches are not very desirable, from a structural standpoint, and should not be used for spans more than 4 or 5 feet at the outside. Occasionally, for the sake of uniformity, a flat arch is used over a larger opening, perhaps a broad window or doorway; but in such cases the weight of the superstructure is carried on iron girders, and the brick arch is only a sham or casing toward the street.

LIME MORTARS

Brickwork endures only according to the proportional strength and quality of the bricks of which it is composed, the mortar that binds them, and the manner of the bonding. It has often been demonstrated that failure in brick wall construction is rarely due to the weakness of the brick, but to that of the mortar. One of the most striking demonstrations of the relative strength of brick and mortar is afforded in a record of tests of arches made by the Austrian Association of Engineers and Architects during 1900-1905. The exceptional conditions under which the tests were made are clearly presented in the following extract from "Engineering" (London, England, 1906):

"The long arches tested were 6.65 feet wide, and 74.5 feet span, with a rise one-fifth the span. They were built in a quarry, between solid rock walls so that all deflections were due to the effect of the load on the arch. A platform supported on six sets of columns, the feet of which rested directly on the extrados of the arch, extended in each case from one abutment to the crown; and the testing was effected by piling rails on this platform.

"The first experiments were made upon an arch of cut stone, and upon one of brick. The stone used was a fairly hard limestone of excellent quality. The voussoirs of both arches

were 1.97 feet thick at the crown, and 3.6 feet deep at the springings. The mortar used was mixed in the proportion of 500 pounds of Portland cement to 35 cubic feet of clean sand.

"The stone arch gave way when the load piled on the platform reached an amount equivalent to 1.99 tons per foot run; and the brick arch, when the load reached 1.81 tons per foot run. Up to the point of rupture, the stone arch gave no signs of incipient failure; but, in the case of the brick arch, cracks declared themselves previously, which were apparently caused by the failure of the mortar, the bricks themselves being intact.

"The arches were 51 days old when they were broken. In failing, radial cracks appeared on the extrados of the loaded side, near the skewback, and on the haunch of the unloaded side.

"The conclusions were that such masonry arches will safely bear a load causing a stress of from $\frac{1}{10}$ to $\frac{1}{4}$ the ultimate crushing strength."

A knowledge of the essential qualities of good lime mortars will be of great assistance to the builder of brick structures. The main function of mortar in brickwork is to unite the brick into one substantial mass; and in so doing, all the crevices between the brick will necessarily be filled up.

Secondarily, the mortar acts as a cushion to take up all the inequalities of the brick-surface. The strength of the mortar is therefore the prime consideration; the filling of the crevices to keep out air and water is a matter of good workmanship; the thickness of the joint determines the effectiveness of the cushioning and pressure-distribution.

All the limes come, of course, from limestone; but, according to the purity of the limestone, we obtain by calcination—**common lime**, **hydraulic lime**, and **"natural" hydraulic cement**. When the

limestone is nearly pure carbonate of lime, common lime is the product. If the limestone contains from 10 to 20 per cent of clay, hydraulic lime results from calcining. With from 20 to 23 per cent of clay, the limestone yields a "natural" hydraulic cement.

Common lime, or "air-lime" requires air-exposure in order that it may set or harden. It will not harden under water. Hydraulic lime and cement will both harden under water.

Common lime is the result of the burning of a pure or nearly pure limestone, in which process the carbon dioxide is driven off and calcium oxide remains. When water is applied to fresh lime, it is absorbed with avidity. The absorption is attended by great heat, steaming, and the breaking-down of the lime mass. If the slaking—as the work of absorption is called—is carried on perfectly, all the lime is reduced to a fine powder, with a volume two or three times that of the original lime, the increase of bulk being proportional to the limestone's purity.

The lime, being slaked, is ready to be made into mortar. A lime paste is formed; and to this, sand is added. The sand prevents the shrinkage of the lime in drying out, just as it does in preventing the shrinkage of clay brick. The sand particles assist (by their coarseness) the action of the carbon dioxide in the air on the calcium oxide in the mortar. A very important advantage of the sand mixture is that it reduces the mortar cost.

Very pure limestones produce **fat** limes, almost white and slaking to an impalpable flour. Where silica, alumina, and other impurities are present, **lean** limes result. These are yellowish or grayish in color. They slake slowly.

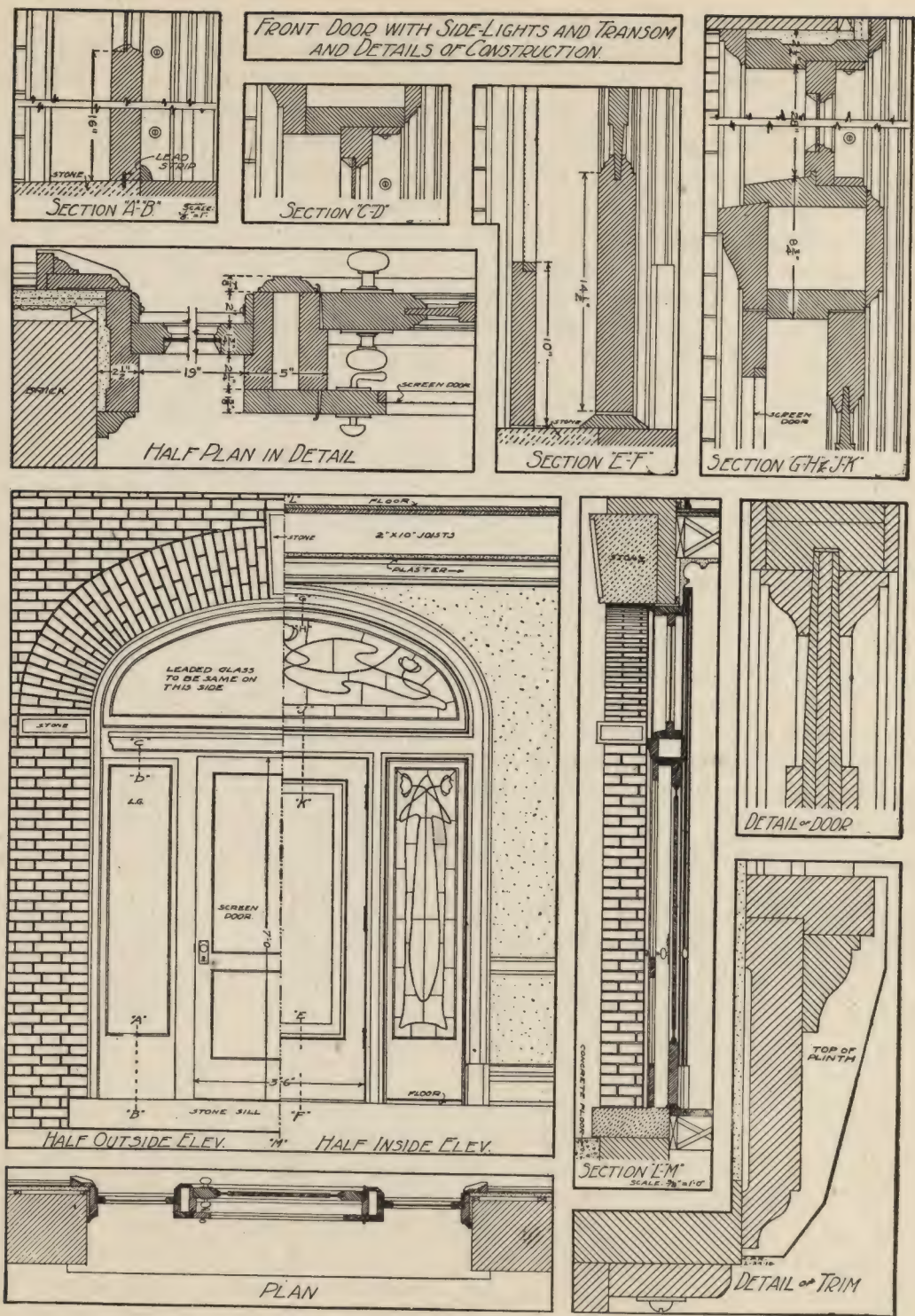
If the limestone is nearly a pure cal-

cium carbonate, the lime is known as a **high-calcium** lime. If the limestone contains over 10 per cent of magnesia, the lime is known as **magnesian** or **dolomitic** lime. The high-calcium limes are called **hot** or **quick** limes; and the magnesian limes are known as **cool** or **slow**. These terms refer to their action in contact with water. In slaking the hot limes, it is better that all the water should be added at once; with the cool limes, the water should be added only gradually. In the latter case, too rapid addition of water would cool the lime mass and stop the slaking, as much less heat is evolved in the breaking-down of magnesian limes. They set more slowly, but finally gain more strength, than the high-calcium limes.

The proper slaking of lime requires knowledge and close attention. Many mortars are low in bonding efficiency, owing to want of care in their making. Builders are regarding with increased favor the hydrated limes that are available. These are slaked to a dry powder in the factory, are perfectly slaked to maximum volume, and are ready for immediate use.

A good lime should be free from impurities, such as cinders, etc., and should slake readily in water to a smooth paste and without any residuum.

The quality of the sand used in mortar-making has a marked effect on the strength of the product. In the specifications, the essentials demanded are expressed in the sentence: "The sand shall be sharp, clean, and coarse." Ocean and lake sands are to be preferred to glacial sands as a rule, the latter containing frequently large quantities of soft and easily decomposed constituents. Sharpness is considered desirable, because the angular



grains of sand invite more ready adhesion to the lime or cement, and offer an arching resistance to compression. Sharp sands, however, present more voids in the mass; and efficiency of mix demands a greater proportion of lime or cement. As few sands have grains of marked sharpness, and the minimum degree of sharpness is not specified, the fulfilment of the specification in this regard is for the most part disregarded. The purchaser gives most attention to the sand's cleanness and coarseness. Sand, if clean, will not show tendency to form lumps by compression in the hand while damp. If the sand does not dirty the hands to any marked degree during its handling, it may be considered clean. Foreign matter, such as wood chips, leaves, paper, etc., cannot be permitted in mortar sands. The presence of clay particles in the sand may be said to be injurious to rich mortars and cements, and beneficial to lean mortars, when in proper proportion, of course, to the degree of leanness.

Coarseness of sand insures easy mixing and the use of the least quantity of cementing material. As a general statement, the coarser sands produce the strongest mortars. The quality of mortar, the thoroughness of the mix, and the percentage of voids would all have to be taken into account in any special consideration of mortar strengths.

CLEANING BRICKWORK

Brick walls in cities and factory towns often become discolored by smoke and soot. A periodical cleaning is therefore advisable, and the brickwork can be restored almost to its original freshness by washing it first with a muriatic acid solution in proportions of $\frac{1}{4}$ pint of the acid to each gallon of

water for every 100 sq. ft. of surface. When dry, the wall is then brushed down with kerosene oil, and this is followed by a coating of linseed oil. This gives a kind of waterproofing to the wall, and is said to mellow the color of red brick in pleasing fashion. Many other cleaning mixtures are in use, in which liquid ammonia and soap are the chief cleaning factors.

Efflorescence. Efflorescence, often termed "whitewash," is a white scum that appears on the surface of brick walls after they have been soaked with rain or in the presence of marked atmospheric humidity. This scum is due to the presence of soluble salts in the clay or the mortar. In some cases, where the clay is the cause, these white patches appear on the brick when taken from the kiln. The presence of sulphuric acid salts on the brick in the drier had not been noticed; and if the brick are well burned, the scum is welded firmly to the clay, and no amount of washing with the strongest acids will remove it. The scum in this case is easily seen by the purchaser, and the brick need not be bought if discolored brick are objectionable.

The brickmaker can remove the cause of trouble by mixing with the clay carbonate of barytes, which, in changing the soluble salts in the clay, such as sulphate of lime, forms insoluble sulphate of barytes and insoluble carbonate of lime. No soluble matter is left in the material, and consequently no scum will appear at any stage of the manufacturing process or when the brick are in service.

The home-builder, contractor, and architect are vitally interested in learning how to deal successfully with efflorescence which appears after the building is erected and which mars the

beauty of the finished structure. If it is present in immediate and general distribution after rain or during very damp weather, the scumming is more likely to have come from the mortar than the clay. The water absorbed by the mortar, in evaporating deposits the salts of soda, magnesia, potash, etc., which it

Chicago, in 1902, the efflorescence was marked throughout the sill length of the 15th story. Each year the line of efflorescence dropped until at the time of writing, but few signs of "white-wash" can be noted, and those on the lowest story.

Waiting for efflorescence to disap-

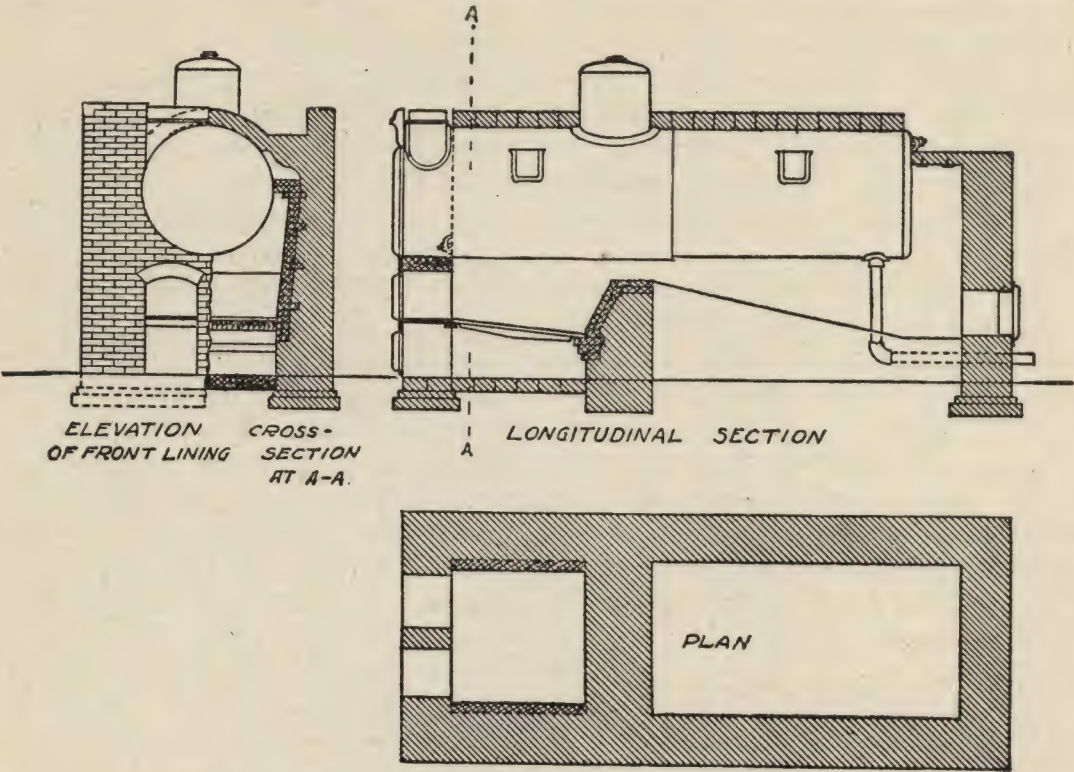


FIG. 113. TUBULAR BOILER IN BRICK SETTING.

has dissolved, and leaves an unsightly scum on the wall surface.

The evaporation of water from the brick brings to the surface the soluble salts from the interior in the same way, but the action is not so rapid as in the case of mortar. In some cases, brick themselves free from these salts may show efflorescence by absorption of water impregnated with the salts in the mortar.

Efflorescence disappears gradually under the action of wind and rains. In the case of the Monadnock Building,

pear, however, is a lengthy operation. A quick way to remove it is by using hydrochloric acid mixed with five times its volume of water. The wall is first thoroughly dampened, then well scrubbed with the acid solution; after scrubbing, the wall should be washed perfectly clean with clear water. Nitric acid is also used for this purpose.

Further efflorescence may be stopped by using a waterproofing compound on the wall. The Sylvester process is one of the best known, and its effect is produced by alum and soap solutions. The

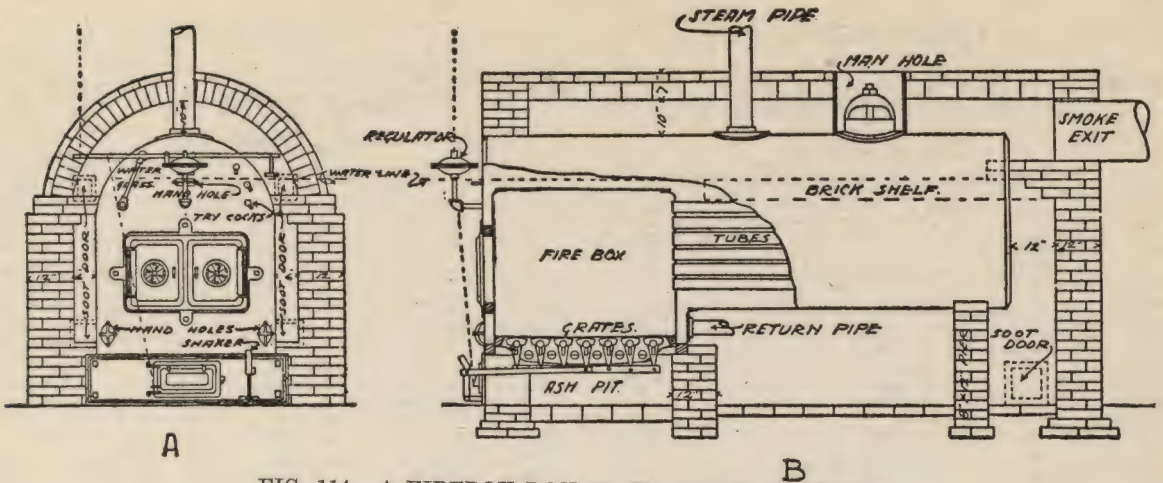


FIG. 114. A FIREBOX BOILER IN BRICK SETTING.

A—Front elevation and section, showing brickwork; B—Side view, showing longitudinal section.

alum solution is made in proportion of 1 lb. of alum to one gallon of water. The soap solution is composed of 2.2 lbs. of good soap dissolved in each gallon of water. The wall surface, at the time of application, must be dry, and not colder than 50 degrees F. The soap solution is applied at boiling temperature. This coat is allowed to dry for 24 hours, when the alum solution, at about 60 to 70 degrees F., is applied. This method of waterproofing has been in use many years and has proved quite effective. As it prevents moisture getting to the brick, it naturally prevents efflorescence also. It is recommended that aluminum sulphate be substituted for alum in the solution noted above, as being cheaper in first cost and in quantity required.

BRICK FOR BOILER SETTINGS

Figs. 113 and 114 show the ordinary forms of boiler settings. That shown in Fig. 113 is for the ordinary form of tubular boiler with what is known as a **full front**, or a cast-iron front which extends the full width of the boiler and from the floor to the top of the brick setting.

Table XVII gives an estimate of the materials required for various sizes of tubular boilers with full fronts.

Fig. 114 shows an ordinary form of horizontal tubular boiler with firebox in

TABLE XVII

Materials Required for Brickwork of Tubular Boilers

(Boilers with Full Front—Single Setting)

SIZE OF BOILERS	COMMON BRICK	FIRE BRICK	SAND (BUSHELS)	CEMENT (BARRELS)	FIRE CLAY (POUNDS)	LIME (BARRELS)
30 in. x 8 ft.	5,200	320	42	5	192	2
30 in. x 10 ft.	5,800	320	46	5½	192	2¼
36 in. x 8 ft.	6,200	480	50	6	288	2½
36 in. x 9 ft.	6,600	480	53	6½	288	2¾
36 in. x 10 ft.	7,000	480	56	7	288	3
36 in. x 12 ft.	7,800	480	62	8	288	3¼
42 in. x 10 ft.	10,000	720	80	10	432	4
42 in. x 12 ft.	10,800	720	86	11	432	4¼
42 in. x 14 ft.	11,600	720	92	11¾	432	4½
42 in. x 16 ft.	12,400	720	99	12½	432	5
48 in. x 10 ft.	12,500	980	100	12½	590	5¼
48 in. x 12 ft.	13,200	980	108	13½	590	5½
48 in. x 14 ft.	14,200	980	116	14½	590	5¾
48 in. x 16 ft.	15,200	980	124	15½	590	6
54 in. x 12 ft.	13,800	1,150	108	13¾	690	5½
54 in. x 14 ft.	14,900	1,150	117	15	690	6
54 in. x 16 ft.	16,000	1,150	126	16	690	6¼
60 in. x 10 ft.	13,500	1,280	108	13½	768	5½
60 in. x 12 ft.	14,800	1,280	118	14¾	768	6
60 in. x 14 ft.	16,100	1,280	128	16	768	6½
60 in. x 16 ft.	17,400	1,280	140	17½	768	7
60 in. x 18 ft.	18,700	1,280	148	18¾	768	7½
66 in. x 16 ft.	19,700	1,400	157	19¾	840	8
66 in. x 18 ft.	21,000	1,400	168	21	840	8½
72 in. x 16 ft.	20,800	1,550	166	20¾	930	8½
72 in. x 18 ft.	22,000	1,550	175	22	930	9

TABLE XVIII

Materials Required for Brickwork of Firebox
Boilers, 9-inch Walls

(Single Setting)

SIZE OF BOILER	BRICK (No.)	SAND (BU.)	CEMENT (BBLs.)	LIME (BBLs.)
30 in. x 6½ ft.	1,640	14	1½	1
30 in. x 7½ ft.	1,820	15	1¾	1
30 in. x 8½ ft.	1,980	16	2	1¼
36 in. x 7½ ft.	2,240	18	2¼	1½
36 in. x 9 ft.	2,520	20	2¾	1¾
36 in. x 10½ ft.	2,870	23	3	2
42 in. x 8½ ft.	2,870	23	3	2
42 in. x 10 ft.	3,400	27	3½	2¼
42 in. x 11½ ft.	3,800	30	4	2½
48 in. x 10½ ft.	3,600	29	3¾	2¼
48 in. x 12 ft.	3,860	30	4	2½
48 in. x 13½ ft.	4,140	33	4½	2¾
54 in. x 14 ft.	5,150	41	5½	3
54 in. x 16½ ft.	5,550	43	5¾	3¼

front end. This form of boiler is used quite extensively for heating purposes. Tables XVIII and XIX give approximate materials required for 9-inch and 12-inch walls respectively.

TABLE XIX

Materials Required for Brickwork of Firebox
Boilers, 12-inch Walls

(Single Setting)

SIZE OF BOILER	BRICK (No.)	SAND (BU.)	CEMENT (BBLs.)	LIME (BBLs.)
30 in. x 6½ ft.	2,400	20	2½	1
30 in. x 7½ ft.	2,650	21	2½	1
30 in. x 8½ ft.	2,900	23	2¾	1¼
36 in. x 7½ ft.	3,150	25	3	1½
36 in. x 9 ft.	3,550	28	3½	1¾
36 in. x 10½ ft.	4,000	31	4	2
42 in. x 8½ ft.	4,000	31	4	2
42 in. x 10 ft.	4,000	38	5	2¼
42 in. x 11½ ft.	5,100	41	5½	2¼
48 in. x 10½ ft.	4,900	40	5½	2¼
48 in. x 12 ft.	5,400	43	5¾	2½
48 in. x 13½ ft.	5,800	46	6	2¾
54 in. x 14 ft.	6,900	54	6¾	3
54 in. x 16½ ft.	7,500	59	7¾	3½

BRICK CISTERNS

Table XX will be found of service in determining the number of bricks required for the construction of cisterns.

TABLE XX

Number of Bricks Required for Cisterns

DIAMETER OF CISTERN IN FEET	DEPTH IN FEET	THICKNESS OF WALL AROUND SIDES, IN IN.	NUMBER OF BRICKS IN WALL, AROUND SIDES	NUMBER OF BRICKS IN BOTTOM, LAID FLAT	NUMBER OF BRICKS IN TOP ARCH, 4 INCHES THICK	NUMBER OF BRICKS IN TOP ARCH, 8 INCHES THICK	SQUARE FEET OF PLASTER ON TOP AND BOTTOM	SQUARE FEET OF PLASTER ON SIDE TO EACH FOOT OF HEIGHT	CUBIC FEET OF EXCAVATION TO EACH FOOT OF DEPTH	CONTENTS OF CISTERN TO EACH FOOT OF DEPTH, IN GALLONS
4	1	4	82	50	150	320	27	12.5	20	94
4	1	8	170	50	150	320	27	12.5	28	94
5	1	4	109	78	200	425	41	15.7	28	147
5	1	8	225	78	200	425	41	15.7	38	147
6	1	4	130	112	275	600	59	18.9	38	212
6	1	8	275	112	275	600	59	18.9	50	212
7	1	4	154	152	375	790	80	22.0	50	288
7	1	8	319	152	375	790	80	22.0	63	288
8	1	4	175	200	485	1,000	105	25.1	63	375
8	1	8	365	200	485	1,000	105	25.1	78	375
9	1	8	430	255	600	1,250	135	28.3	78	476
9	1	12	615	255	600	1,250	135	28.3	95	476
10	1	8	475	314	730	1,525	165	31.4	113	585
10	1	12	680	314	730	1,525	165	31.4	132	585
11	1	8	520	380	870	1,800	200	34.6	132	710
11	1	12	740	380	870	1,800	200	34.6	153	710
12	1	12	876	452	1,025	2,125	240	37.7	176	847
13	1	12	880	530	1,175	2,425	280	40.8	201	992
14	1	12	940	616	1,350	2,800	330	44.0	226	1,153
15	1	12	1,000	705	1,550	3,200	375	47.1	254	1,340

To use Table XX, multiply the number of bricks in column corresponding to the diameter and thickness of wall desired, by the depth of the cistern; and add the number required for the top and bottom. The top should have a rise of about one-fifth the diameter.

To reduce the capacity of the cistern to barrels, divide contents in gallons by 31.5.

BRICK SEWERS

The materials required for the construction of sewers can be determined by use of the following tables—Tables XXI and XXII for **circular sewers**; and Table XXIII for **egg-shaped sewers**.

The cost of brickwork laid in sewers ranges from \$10 to \$15 per cubic yard.

Table XXIV, compiled by G. H. Brown and published in "Municipal

TABLE XXI

Materials Required for Circular Sewers One Foot in Length and Four Inches or One Ring Thick

(Brick $8\frac{1}{4} \times 4 \times 2\frac{1}{4}$ Inches)

Diameter of Sewer, feet.	2	2½	3	3½	4	5
Number of bricks.....	42	53	63	73	83	105
Barrels of cement per 100 linear feet	9	11	13	15	17	20
Barrels of sand per 100 linear feet	18	22	26	30	34	40

TABLE XXII

Materials Required for Circular Sewers One Foot in Length and Eight Inches or Two Rings Thick

(Brick $8\frac{1}{4} \times 4 \times 2\frac{1}{4}$ Inches)

Diameter of Sewer, feet	2	2½	3	3½	4	5	6	8	10
Number of bricks..	115	150	170	195	215	230	305	395	480
Barrels of cement per 100 linear ft.	17	19	22	25	27	34	40	60	75
Barrels of sand per 100 linear ft....	34	38	44	50	54	68	80	120	150

TABLE XXIII

Materials Required for Egg-Shaped Sewers One Foot in Length and Eight Inches or Two Rings Thick

(Brick $8\frac{1}{4} \times 4 \times 2\frac{1}{4}$ Inches)

Inside Dimensions, feet.....	2 x 3	2½ x 3½	2½ x 3½	2½ x 3½	2½ x 4	3 x 4½	3½ x 5½	4 x 6	5 x 7½
Number of bricks..	145	160	170	178	185	205	235	260	315
Barrels of cement per 100 linear ft.	19	21	22	23	25	27	34	38	41
Barrels of sand per 100 linear ft....	38	42	44	46	50	54	68	76	82

TABLE XXIV

Number of Brick in Circular Sewers

Size of brick $2\frac{1}{2} \times 4 \times 8\frac{1}{2}$ inches. Joints $\frac{1}{4}$ inch, except between rings $\frac{3}{8}$ inch.)

DIAMETER	1 RING	2 RINGS	3 RINGS	ONE LINEAR FT. OF SEWER		
				1 RING	2 RINGS	3 RINGS
24 in.	27.42	64.83	112.24	37.60	88.90	153.93
30 in.	34.30	78.54	132.80	47.00	107.71	182.12
36 in.	41.13	92.25	153.37	56.40	126.51	210.34
40 in.	45.70	101.38	167.07	62.67	139.03	229.12
45 in.	51.40	112.81	184.21	70.50	154.71	252.63
48 in.	54.83	119.66	194.50	75.20	164.10	266.74
54 in.	61.69	133.37	215.05	84.60	182.90	294.92
60 in.	68.54	147.08	235.62	94.00	201.70	323.13
66 in.	75.40	160.79	256.18	103.40	220.51	351.33
72 in.	82.25	174.50	276.74	112.80	239.31	379.52
78 in.	89.10	188.21	297.30	122.19	258.11	407.72
84 in.	95.96	201.92	317.87	131.60	276.92	435.93
90 in.	102.81	215.62	338.43	140.99	295.70	464.13
96 in.	109.67	229.33	359.00	150.40	314.51	492.34

(Size of brick $2\frac{1}{2} \times 4 \times 8\frac{1}{2}$ inches. Joints $\frac{3}{8}$ inch, except between rings $\frac{1}{2}$ inch.)

DIAMETER	1 RING	2 RINGS	3 RINGS	ONE LINEAR FT. OF SEWER		
				1 RING	2 RINGS	3 RINGS
24 in.	26.22	62.28	108.18	35.45	84.20	146.26
30 in.	32.78	75.40	127.85	44.32	101.94	172.85
36 in.	39.34	88.51	147.52	53.19	119.66	199.45
40 in.	43.71	97.25	160.63	59.09	131.48	217.17
45 in.	49.17	108.18	177.02	66.47	146.25	239.33
48 in.	52.45	114.74	186.86	70.91	155.13	252.63
54 in.	59.00	127.85	206.52	79.77	172.85	279.21
60 in.	65.56	140.96	226.19	88.63	190.57	305.81
66 in.	72.12	154.07	245.86	97.50	208.30	332.40
72 in.	78.67	167.19	265.53	106.36	226.04	358.99
78 in.	85.23	180.30	285.20	115.23	243.76	385.59
84 in.	91.79	193.41	304.87	124.10	261.49	412.18
90 in.	98.34	206.52	324.54	132.95	279.21	438.78
96 in.	104.90	219.64	344.20	141.82	296.95	465.36

Engineering," shows the number of brick required for circular sewers with different thicknesses of joints.

Flush-Tanks. Table XXV gives the number of common sized bricks required for the construction of flush-tanks of various sizes.

BRICK PAVING

The character of street paving exerts a marked influence on property values. A paving in bad condition lowers the civic sense of those who reside in the structures that flank it. Well-built houses and well-built streets



FIG. 115. GRADING A STREET FOR BRICK PAVEMENT.

TABLE XXV

Number of Bricks in Flush-Tanks
(12-inch Walls—Brick 8¼x4x2¼ Inches)

INSIDE DIAM. (Feet)	DEPTH, IN FEET				
	5	6	7	8	9
4	1,124	1,344	1,560	1,780	2,000
5	1,417	1,680	1,940	2,200	2,460
6	1,820	2,440	3,060	3,680	4,300

are the basic factors in the building-up of what is known as a "good neighborhood;" and rent values and property prices are always at high tide in such districts.

Brick pavements, constructed of brick conforming to the specifications herewith reproduced and laid in the manner set forth in them, are conceded by many municipal authorities to be the most durable pavements in exist-

ence. Many brick streets have been down 10 and 15 years, without a cent of repairs having been made on them, the paving surfaces still being in first-class condition.

Brick paving offers greatest ease of traction under varying season conditions. It is unaffected by animal uric acids and underground gases. It does not of itself originate dust or mud, as do pavements of macadam and stone-compounded surfaces. Brick paving is smooth, yet not slippery.

The brick house is at its best when approached by a brick pavement. Its owner will not be confronted by heavy maintenance costs.

The bricks used for paving, as already stated, are about $8\frac{1}{2} \times 4 \times 2\frac{1}{2}$ inches in size. Another size of brick,

pitched joints such as shown in Fig. 117 is about \$2.60 per square yard; while the cost of the curbing as shown, is about 45 cents per linear foot.

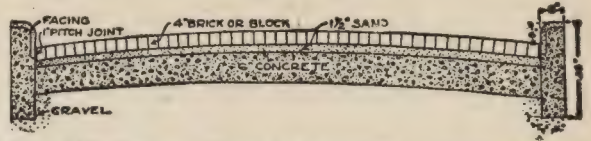


Fig. 117. Section of Brick Pavement, Showing Method of Construction.

SPECIFICATIONS FOR PAVING, ETC.

The following specifications regarding brick street paving represent the standard practice adopted by the Board of Local Improvements of the City of Chicago, Illinois:

Cement. In making the concrete, Portland cement shall pass same specifications as for cement used in curb and gutter work.



FIG. 116. MIXING CONCRETE FOR BRICK PAVEMENT.

commonly called a **block**, is $9 \times 4 \times 3$ inches in size.

The general method of laying brick pavements is illustrated in Fig. 117.

The cost of a brick pavement with

Sand. The sand used in making the concrete shall be clean, dry, free from dust, loam, and dirt, of sizes ranging from $\frac{1}{8}$ inch down to the finest, and in such proportion that the voids as determined by saturation shall not exceed 33 per cent of the entire volume; and

it shall weigh not less than 100 pounds per cubic foot. No wind-drifted sand shall be used.

The sand when delivered on the street shall be deposited on flooring, and kept clean until used.

Crushed Stone. The crushed stone used in making the concrete shall be of the best quality of limestone, clean, free from dirt, broken so as to measure not more than 2 inches, and not less than 1 inch, in any dimension.

The stone when delivered on the street shall be deposited on flooring, and kept clean until used.

Mixing and Laying of Concrete. The concrete shall be mixed on movable, tight, iron platforms of such size as shall accommodate the manipulations hereinafter specified.

The cement, sand, and stone shall be mixed in the following proportions: One (1) part of cement, three (3) parts of sand, and seven (7) parts of crushed stone. The sand and cement shall be thoroughly mixed, dry, to which sufficient water shall be added, and then made into a stiff mortar. The crushed stone shall then be immediately incorporated in the mortar, and the mass thoroughly mixed, adding water from time to time as the mixing progresses, until each particle of stone is covered with mortar.

The concrete shall be removed from the platform with shovels, and deposited in a layer on the roadway in such quantities that after being rammed in place it shall be of the required thickness; and the upper surface shall be true and smooth, and — inches below and parallel with the top of the finished pavement.

During the progress of the work, the subgrade must be kept moist.

The concrete shall be sprinkled so as to prevent checking in hot weather, and shall be protected from injury at all times; and shall lie at least seven days before being covered with the wearing surface, or a longer time if deemed necessary.

Sand Cushion. Upon the concrete foundation, shall be spread a layer of sand in such quantity as to insure, when compacted, a uniform thickness of 1 inch.

In surfacing said layer of sand, the Contractor or contractors shall use such guides and templets as the Engineer may direct.

Wearing Surface. Upon the layer of sand as above specified, shall be placed the brick, of such quality and in such manner as hereinafter specified.

Quality of Bricks. The brick to be used shall be of the best quality of vitrified paving brick. Salt-glazed bricks will not be received.

The dimensions of the brick used shall be the same throughout the entire work in any particular case, and shall be not less than 8 inches in length, 4 inches in depth, and $2\frac{1}{2}$ inches in thickness, with rounded edges to a radius of $\frac{1}{4}$ of an inch.

Said brick shall be of a kind known as **re-pressed vitrified paving brick**, and shall be repressed to the extent that the maximum amount of material is forced into them. They shall be free from lime and other impurities; shall be as nearly uniform in every respect as possible; shall be burned so as to secure the maximum hardness, so annealed as to reach the ultimate degree of toughness, and thoroughly vitrified so as to make a homogeneous mass.

The bricks shall be free from all laminations caused by the process of manufacture, and free from fire-cracks or checks of more than superficial character or extent.

Any firm, person, or corporation bidding for the work to be done, shall furnish specimen brick, which shall be submitted to a **water-absorption test**; and if such brick show a water absorption exceeding 3 per cent of their weight when dry, the bid of the person, firm, or corporation so furnishing the same shall be rejected. Such water-absorption test shall be made by the Board of Local Improvements of the City of Chicago, in the following manner, to wit: Not less than 3 bricks shall be broken across, thoroughly dried, and then immersed in water for 72 hours. The absorption shall then be determined by the difference between the weight dry and the weight at the expiration of said 72 hours.

Twenty or more specimen bricks shall also be furnished by each bidder, for submission to

the abrasion test by the Board of Local Improvements. Such test shall be made in the following manner, to wit: Such specimen brick, or a sufficient number to fill 15 per cent of the volume of the rattler, shall be submitted to a test for one hour in the machine known as the **rattler**, which shall measure 20 inches in length and 28 inches in diameter, inside measurement, and shall be revolved at the rate of 30 revolutions per minute. If the loss of weight by abrasion during such test shall exceed 20 per cent of the original weight of the brick tested, then such bid shall be rejected.

All brick shall have a specific gravity of not less than 2.1, as determined by the formula:

$$\text{Specific Gravity} = \frac{W}{W'W''}$$

where **W** equals weight of brick dry, **W'** equals weight of brick after being immersed in water for 72 hours, and **W''** equals weight of brick in water.

All brick used must be equal in every respect to the specimen submitted by the bidders to the Board of Local Improvements for test.

How Laid. All brick shall be delivered on the work in barrows; and in no case will teams be allowed on the street before the wearing surface is rolled.

Broken bricks can be used only to break joints in starting courses and in making closures, but in no case shall less than half a brick be used.

The bricks shall be laid on edge, close together, in straight lines across the roadway, between gutters; and at right angles to the curbs, and perpendicular to the grade of the street. Gutters shall be constructed as directed by the Engineer.

The joints shall be broken by a lap of not less than 3 inches.

On intersections and junctions of lateral streets, the bricks shall be laid at an angle of 45 degrees with the line of the street, unless otherwise ordered by the Engineer.

The bricks, when set, shall be rolled with a roller weighing not less than 5 tons, until the

bricks are well settled and made firm. Or, if the Engineer shall direct, the bricks, when set, shall be thoroughly rammed two or more times, the ramming to be done under a flatter, with a paving rammer weighing not less than 30 pounds, the iron of the rammer face in no case to come in contact with the pavement.

After rolling and ramming, all broken brick found in the pavement must be at once removed and replaced by sound and perfect brick.



Fig. 118. Laying Concrete Base for Brick Pavement.

Pitching or Grouting, and Top-Dressing.

When the bricks are thoroughly bedded, the surface of the pavement must be true for grade and crown. The surface of the pavement shall then be swept clean; and the joints or spaces between the brick shall be completely filled with a paving pitch which is the direct result of the distillation of "straight-run" coal-tar, and of such quality and consistency as shall be approved by the Board of Local Improvements. The pitch must be used at a temperature of not less than 280 degrees Fahrenheit.

When the brick are thoroughly bedded, the surface of the pavement must be true for grade and crown. The surface of the pavement shall then be swept clean, and the joints or spaces between the bricks shall be filled with a cement grout filler composed of limestone 65 per cent,

TABLE XXVI
Covering Capacity of Paving Brick

SIZE OF BRICK	NUMBER REQUIRED FOR EACH SQUARE FOOT		SIZE OF BRICK	NUMBER REQUIRED FOR EACH SQUARE FOOT	
	Laid on Edge	Laid Flat		Laid on Edge	Laid Flat
2 x4 x8 in.	9	4.5	3 x4½x9 in.	5.3	3.5
2¼x4¼x8¼ in.	7.7	4.5	4 x4 x8 in.	4.5	4.5
2½x4½x8½ in.	6.7	3.7	4 x4 x9 in.	4	4
2½x4½x9 in.	6.4	3.5	4½x4½x8½ in.	3.7	3.7
3 x4 x8 in.	6	4.5	4½x4 x9 in.	3.5	3.5
3 x4½x8½ in.	5.6	3.7			

furnace slag 25 per cent, and potter's clay 10 per cent, to be made as follows: The above materials, in the proportions stated, shall be mixed together and ground into an impalpable powder, and then burned in kilns until reduced to clinker, after which it shall again be ground into an impalpable powder. Equal portions of said grout and clean, sharp sand shall then be thoroughly mixed, and sufficient water added to bring the mixture to such a consistency as will allow it to run to the bottom of the joints between the brick. After said joints are filled to the top, the surface shall be finished off smooth with steel brooms.

After the spaces between the brick have been filled with the pitch or grout as above specified, the surface of the pavement shall then receive a ½-inch dressing of sand, evenly spread over the whole surface.

Where cement grout is used as a filler, the pavement must be kept clear of traffic for a period of 4 days—or as much longer as the Engineer may direct—after the application thereof.

In determining the number of brick necessary for paving any desired area, Table XXVI will be found of assistance.

COST OF BRICK PAVEMENTS

The following items are to be taken into consideration in figuring on the cost of brick pavements:

- Cost of grading street 15 to 50c. per cu. yd.
- Average value in easy soil and moderate cuts 20 to 30c. per cu. yd.
- Dressing off sub-grade and loading material into wagons 2½ to 3c. sq. yd.

- Rolling with horse roller, longitudinally 0.1 to .15c. sq. yd.
- (With interest on investment in roller per year, may be as high as ½ to 1c. sq yd.)
- Rolling with steam roller, longitudinally and transversely, without interest, depreciation, or storage ½c. sq. yd.
- Cost of 6-inch course of concrete:
- Materials40c. sq. yd.
- Labor6 to 8c. sq. yd.
- *Price of brick per thousand, at kiln....\$7.00 to \$15.00
- (Size 2½ x 4 x 8½ in.) Average 8.00 to 10.00
- Cost per sq. yd., exclusive of freight.....43 to 54c.
- Price of repressed blocks per thousand, at kiln\$12.00 to \$14.00
- (Size 3 x 4 x 9 in.)
- Cost per sq. yd., exclusive of freight.....55 to 65c.
- Cost of hauling and piling on side of street (haul of 1 mile; three wagons with each team)\$1.00 per 1,000
- †Number of bricks set by 1 man per day:
- Average man....10,000 to 12,000 (small) in 10 hrs.

- *In estimating freight, a brick
- 2 x 4 x 8 inches weighs about 5 pounds.
- 2½ x 4 x 8½ inches weighs about 7 pounds.
- 3 x 4 x 9 inches weighs about 9 pounds.
- Loss in broken and rejected bricks, from 2 to 4 per cent.

- †Prof. Ira O. Baker, in "Roads and Pavements," says: "The organization of a paving gang is usually about as follows:
- 1 Man in charge of spreading the sand cushion....\$ 2.50
- 1 Helper on the sand cushion 1.50
- 6 Men wheeling blocks from wagons 9.00
- 4 Men setting blocks 10.00
- 1 Man sweeping pavement and filling joints with sand 1.50
- 1 Foreman in general charge..... 5.00

Total per day of 10 hours\$29.50
"This gang should at least lay 1,000 square yards in 10 hours."

Expert	15,000 (small) in 10 hrs.
Average man	8,000 to 10,000 (large) in 10 hrs.
Expert	10,000 to 12,000 (large) in 10 hrs.

Cost of filling joints in a brick pavement:

With sand	2c. sq. yd.
With tar	10 to 12c. sq. yd.
With Portland cement grout, mixed in small lots	10 to 12c. sq. yd.

give the following costs, which may be used in checking detailed local estimates:

Brick work only, 15 to 20 cents per square yard.

Brick, 4 inches of brick on 3 inches of sand, 65 to 85 cents per square yard; 4 inches of brick on 6 inches of natural cement concrete



FIG. 119. GROUTING AND SANDING A BRICK PAVEMENT.

With Portland cement grout, uniform brick,
thin joints 9 or 10c. sq. yd.

Cost of expansion joints:

1 gal. tar at 8c. for each 5 or 6 sq. yds. of
pavement 1½c. sq. yd.

Add, also, cost of administration, tools, profits, etc.

If brick blocks are piled at side of street, add 2
or 3 cents per square yard.

The prices of labor and material will vary from the above according to the locality, and this outline may be changed to suit local conditions.

Other estimates taken from various sources

and 1½-inch cushion of sand, \$1.20 to \$1.60 per square yard; sidewalks, 2 inches of brick on sand, 50 to 80 cents per square yard.

Tables XXVII and XXVIII may be used in computing the number of bricks required for the foundation and top courses respectively of pavements.

The following analysis of the cost of brick paving is taken from "Engineering News," July 24, 1902:

"The following is a summary of the cost of paving with brick laid on edge, wages being 25

TABLE XXVII

Number of Bricks Required for One Square Yard of Pavement Foundation Course

(Brick Laid Flatwise with 1/4-inch Joints)
(Prof. Ira O. Baker.)

LENGTH OF BRICK (Inches)	WIDTH OF BRICK, IN INCHES										
	3 1/2	3 3/8	3 3/4	3 7/8	4	4 1/8	4 1/4	4 3/8	4 1/2	5	
7 3/4	43.2	41.8	40.5	39.3	38.1	37.0	36.0	35.1	34.1	30.9	
7 7/8	42.5	41.2	39.9	38.7	37.6	36.4	35.4	34.6	33.6	30.4	
8	42.0	40.5	39.3	38.1	36.9	35.9	34.9	34.0	33.1	29.9	
8 1/8	41.3	39.9	38.7	37.6	36.4	35.3	34.4	33.5	32.6	29.5	
8 1/4	40.6	39.3	38.1	37.0	35.9	34.8	33.9	33.0	32.1	29.1	
8 3/8	40.1	38.7	37.6	36.5	35.4	34.3	33.4	32.6	31.6	28.6	
8 1/2	39.5	38.2	37.0	36.0	34.8	33.8	32.9	32.1	31.1	28.2	
8 5/8	38.9	37.7	36.5	35.4	34.4	33.3	32.5	31.6	30.7	27.8	
8 3/4	38.4	37.1	36.0	35.0	33.9	32.9	32.0	31.1	30.3	27.4	
8 7/8	37.9	36.6	35.5	34.5	33.4	32.5	31.5	30.7	29.9	27.1	
9	37.3	36.1	35.1	34.0	33.0	32.0	31.1	30.3	29.5	26.7	
10	33.8	34.1	31.0	30.7	29.7	28.9	28.1	27.4	26.6	24.1	

cents per hour for pavers and 15 cents for laborers:

Cost of Brick Paving

Cost per Square Yard

57 "pavers" at \$10 per M.	\$0.57
Hauling 1 1/2 miles over earth roads	.06
Laying pavers, including labor of grouting	.08
0.18 cu. ft. = 1/150 cu. yd. of grout*	.05
1/36 cu. yd. sand cushion at \$1.08 a cu. yd.	.03
Planks to protect concrete	.01

Total net cost	\$0.80
Add about 19 per cent for profit	.15

Contract price\$0.95

* 1 part Portland cement to 2 parts sand.
"To this, of course, must be added the cost of grading and cost of concrete foundation."

TILE WORK

The vigorous sanitary campaigns now being carried on by the Health Boards of several great States—notably Ohio and Michigan—and by a number of the Health Commissions of leading cities, such as Chicago, New York, and Pittsburgh, has concentrated the home-builder's attention on materials which will assist in keeping the home in a sanitary condition. Mosaic tiles for lobbies and bathrooms, and tile wainscoting for vestibules, kitch-

TABLE XXVIII

Number of Bricks Required for One Square Yard of Pavement Top Course

The upper number in each case is for 1/8-inch joints, and the lower for 1/4-inch joints.
(Prof. Ira O. Baker.)

LENGTH OF BRICK (Inches)	THICKNESS OF BRICK, IN INCHES											
	1 7/8	2	2 1/8	2 1/4	2 3/8	2 1/2	2 5/8	2 3/4	2 7/8	3	4	
7 3/4	82.1	77.6	73.2	69.3	65.8	62.8	59.7	57.5	54.9	52.7	39.9	
	76.2	72.0	68.0	64.8	61.8	58.9	56.4	54.0	52.0	49.8	38.1	
7 7/8	81.1	76.2	72.0	68.0	64.8	61.8	58.9	56.4	54.0	52.0	39.3	
	75.3	70.8	67.2	63.9	60.8	58.1	55.4	53.1	51.1	49.1	37.6	
8	80.1	75.3	70.8	67.2	63.9	60.8	58.1	55.4	53.1	51.1	38.7	
	74.1	69.8	66.1	62.9	60.0	57.0	54.4	52.5	50.8	48.4	36.9	
8 1/8	78.5	74.1	69.8	66.1	62.9	60.0	57.1	54.4	52.5	50.4	38.1	
	72.8	58.9	65.1	62.0	59.2	56.4	53.8	51.6	49.7	47.7	36.4	
8 1/4	77.1	72.8	58.9	65.1	62.0	59.2	56.4	53.8	51.6	49.7	37.6	
	72.0	67.9	64.2	61.1	58.1	55.5	52.9	50.8	48.9	47.0	35.9	
8 3/8	76.2	72.0	67.9	64.2	61.1	58.1	55.5	52.9	50.8	48.9	37.0	
	70.8	66.8	63.2	60.0	57.4	54.7	52.3	50.0	48.2	46.3	35.3	
8 1/2	75.4	70.8	66.8	63.2	60.0	57.4	54.7	52.3	50.0	48.2	36.5	
	69.7	65.8	62.3	59.2	56.6	53.8	51.4	49.3	47.5	45.7	34.8	
8 5/8	74.1	69.7	65.8	62.3	59.2	56.6	53.8	51.4	49.3	47.5	36.0	
	68.9	64.8	61.4	58.4	55.9	53.1	50.6	48.7	46.8	45.1	34.4	
8 3/4	73.2	68.9	64.9	61.4	58.4	55.9	53.1	50.0	47.7	46.8	35.4	
	67.9	63.8	60.6	57.6	54.9	52.5	50.0	48.0	46.1	44.4	34.0	
8 7/8	72.0	67.9	63.8	60.6	57.6	54.9	52.5	50.8	48.0	46.0	35.0	
	67.1	63.2	59.7	56.8	54.2	51.6	49.3	47.3	45.5	43.7	33.4	
9	71.2	67.1	63.2	59.7	56.8	54.2	51.6	49.3	47.2	45.5	34.5	
	66.1	62.3	58.9	56.1	53.6	51.0	48.7	46.8	44.9	43.1	33.0	
10	64.1	60.3	58.6	53.8	51.2	48.9	46.6	44.5	42.6	41.0	31.1	
	59.7	56.1	52.9	50.6	48.3	45.9	44.1	42.2	40.5	38.9	29.7	

ens, and bathrooms, are now being considered indispensable in up-to-date sanitary construction.

When tile work is to be estimated, Table XXIX will prove of value to the contractor. This table gives not only the shape and size of many of the common tiles, but also gives the number of each kind which is required to fill exactly one square foot of space. An allowance of a small number shall be made for breakage and losses.

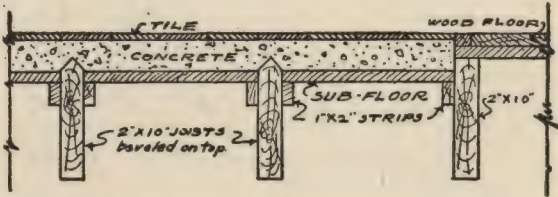


Fig. 120. Detail Section of Art or Mosaic Tile Floor.

It is often necessary to lay a tile or mosaic floor in rooms where wood joists are used. This detail shows the best method of construction for this work. The tops of all the joists under the cement foundation are beveled to prevent the concrete from cracking.

TABLE XXIX

Number of Tiles Required per Square Foot of
Area to be Covered

SHAPE OF TILE	SIZE IN INCHES	NUMBER IN Sq. Ft.
Square.....	6x6	4
Diagonal 1/2.....	6x6	8
Square.....	4 1/4 x 4 1/4	8
Diagonal 1/2.....	4 1/4 x 4 1/4	16
Square.....	3x3	16
Diagonal 1/2.....	3x3	32
Square.....	2 1/8 x 2 1/8	32
Diagonal 1/2.....	2 1/8 x 2 1/8	64
Square.....	1 1/2 x 1 1/2	64
Diagonal 1/2.....	1 1/2 x 1 1/2	128
Square.....	1 1/8 x 1 1/8	128
Diagonal 1/2.....	1 1/8 x 1 1/8	256
Square.....	2x2	36
Square.....	1x1	144
Oblong.....	6x4	6
Oblong.....	6x3	8
Oblong.....	6x2	12
Oblong.....	6x1 1/2	16
Oblong.....	6x1	24
Oblong.....	4 1/4 x 2 1/8	16
Oblong.....	4 1/4 x 1 1/8	32
Oblong.....	3x1 1/2	32
Oblong.....	3x1	48
Oblong.....	2 1/8 x 1 1/8	64
Octagon.....	6x6	4 4/7
Octagon Diagonal 1/2.....	6x6	9 1/7
Octagon Square 1/2.....	6x6	9 1/7
Octagon Square 1/4.....	6x6	18 2/7
Hexagon.....	6x3	10 2/3
Hexagon Long 1/2.....	6x3	21 1/3
Hexagon Short 1/2.....	6x3	21 1/2
Octagon.....	3x3	18 2/7
Hexagon.....	6x5 1/8	6 1/6
Hexagon Diagonal 1/2.....	6x5 1/8	12 1/3
Hexagon Square 1/2.....	6x5 1/8	12 1/3
Pentagon.....	5 1/8 x 2 1/8	12 2/9
Octagon.....	4 1/4 x 4 1/4	9 1/7
Octagon Diagonal 1/2.....	4 1/4 x 4 1/4	18 2/7
Octagon Square 1/2.....	4 1/4 x 4 1/4	18 2/7
Oblong.....	3x1 1/2	96
Oblong.....	6x1 1/2	48
Hexagon.....	4 1/4 x 2 1/8	21 1/3
Hexagon Short 1/2.....	4 1/4 x 2 1/8	42 2/3
Hexagon Long 1/2.....	4 1/4 x 2 1/8	42 2/3
Square.....	1 1/2 x 1 1/2	576
Oblong.....	6x3 1/4	32
Hexagon.....	3x3 3/8	18 2/7
Hexagon Diagonal 1/2.....	3x3 3/8	36 4/7
Hexagon Square 1/2.....	3x3 3/8	36 4/7
Oblong.....	3x1 1/4	192
Hexagon.....	2x2 1/8	41 1/2
Hexagon Diagonal 1/2.....	2x2 1/8	83
Hexagon Square 1/2.....	2x2 1/8	83
Oblong.....	9x3	5 1/3
Oblong.....	6x4 1/4	5 11/17
Oblong.....	1 1/8 x 1 1/8	256
Oblong.....	5x10	2 22/25
Hexagon.....	2 1/8 x 2 1/8	31 2/10
Hexagon Diagonal 1/2.....	2 1/8 x 2 1/8	62 3/5
Hexagon Square 1/2.....	2 1/8 x 2 1/8	62 3/5
Hexagon.....	1 3/4 x 2	54 1/4
Hexagon Diagonal 1/2.....	1 3/4 x 2	108 1/2
Hexagon Square 1/2.....	1 3/4 x 2	108 1/2
Triangle.....	3	37

TABLE XXIX—(Concluded)

Number of Tiles Required per Square Foot of
Area to be Covered

SHAPE OF TILE	SIZE IN INCHES	NUMBER IN Sq. Ft.
Half Triangle.....	3	74
Triangle.....	1 47/64	109 5/7
Half Triangle.....	1 47/64	219 3/7
Triangle.....	1 5/32	249
Half Triangle.....	1 5/32	298

For example, if we have a section of tile wainscoting 8 feet long and 5 feet high, composed of oblong white tiles 6 x 1 1/2 inches in size, and a border along the top made from blue and white triangle or diagonal tile 6 x 6 inches in size, to find the number of tiles needed for this piece of work, we proceed as follows:

The area to be covered by the oblong tiles is 8 ft. long and 4 1/2 ft. high.

$$8 \times 4\frac{1}{2} = 36 \text{ square feet.}$$

There are 144 square inches in one square foot; therefore,

$$36 \times 144 = 5,184 \text{ square inches.}$$

Now, since 1 oblong tile, size 6 x 1 1/2 inches, contains:

$$6 \times 1\frac{1}{2} = 9 \text{ square inches,}$$

the exact number of tiles needed for the part 8 ft. long below the border, is:

$$\frac{5,184}{9} = 576 \text{ tiles.}$$

Better make this 600, to allow for loss and breakage.

Now that we have seen the principle involved in this calculation, we shall explain the method of using Table XXIX, and see if the results check in value. From our figures above, we have 36 square feet below the border. This space is to be filled with 6 x 1 1/2-inch tiles. From the table, the number of 6 x 1 1/2-inch oblong tiles which are necessary to cover one square foot of surface is 16. Therefore,

$$36 \times 16 = 576 \text{ tiles required.}$$

This result checks with our first figures.

For the border of diagonal tiles, we have an area 8 feet long by 1/2 foot high which is to be filled.

$$8 \times \frac{1}{2} = 4 \text{ square feet.}$$

From the table (second line from top), we find that we shall need 8 diagonal 6x6-inch tiles per square foot.

Therefore,

$$4 \times 8 = 32 \text{ tiles required for border.}$$

Better make this 40, to allow again for loss and breakage. This would mean 20 blue and 20 white diagonal tiles.

This same principle may be used in figuring other sizes of walls, and in using other sizes of tiles.

BRICK CHIMNEY CONSTRUCTION

A brick chimney must be carefully planned. Its size and height must be proportioned to the number, arrangement, and size of flues composing it. Modern demands for comfort, attained in cold weather by up-to-date hot-air, steam, and hot-water heating plants, enforce the necessity of accurate chimney construction. Quality of construction is also demanded to reduce the fire hazard to a minimum. Many old buildings confront the heating contractor with flues 4x8 or 4x12 or 4x16 in., showing total disregard of the essentials of draft production.

The chimney-flue of a residence must serve a double purpose: it must maintain a relatively steady draft under varying atmospheric conditions; and it must carry up and away the gases and smoke resulting from the combustion of fuel in the furnace or boiler.

The chimney must have, according to the best modern practice, a draft equaling the pressure of from 15/100 to 2/10 of an inch of water. It must also have sufficient area in square inches at that draft to discharge all smoke and gases at all stages of combustion, from its top, without excess of friction.

The draft of a chimney is affected by varying atmospheric pressures and

temperatures, by humidity, and by the quality of the brickwork in its relation to leakage and absorption. The work the chimney is to perform is governed by the quality of the fuel, the quantity of the fuel, and the varying conditions of the fire during the different stages of the fuel's combustion.

Every boiler manufacturer gives the smoke-pipe size for each size and type of boiler he manufactures. It would be manifestly absurd to construct the chimney of a house without giving due consideration to the demands which will be made upon it when the chimney is called upon to do its work under the most severe conditions. It must always be borne in mind that the chimney is not meant primarily to be an ornament. Its mission is to provide for the heating of the residence to 70 degrees F. when the outside temperature is zero. Any heating system that cannot do that is not a heating system. If the fault lies with the furnace or boiler, it can be remedied without much trouble by replacing it with a more efficient installation. If the cause of trouble is the chimney, the remedy involves structural changes, in many cases entailing expense and inconvenience which could have been avoided by intelligent planning in the house-building.

There should be no outside interference with the draft of a chimney. The chimney-top should not be lower than any projecting portion of the building, or even on a level with it. If near-by buildings will affect the draft, allowance for this must be made; overhanging trees causing draft interference must also be taken into consideration, and the obstruction removed.

Another evil of chimney construction is that of topping chimneys with cap-

stones whose small openings restrict the area of the chimney's delivery from 20 to 30 per cent. For instance, an 8x12 chimney with two 5x6-in. holes in its capstone, has its area of delivery reduced from 96 to 60 sq. in.

The intelligent builder will know beforehand the amount of radiation required to heat the house he is going to construct, and will without doubt select the heating equipment which best meets his heating requirements at the time the final plans for the structure are being made.

Table XXX,* which indicates the approximate sizes of chimney-flues for steam and hot-water heating in residences and other buildings, will prove of service to our readers.

The Chimney Flue. It is probable that ninety per cent of the failures of heating apparatus to heat properly (when a heater of sufficient size and the proper amount of radiating surface

TABLE XXX

Approximate Sizes of Chimney Flues for Steam and Hot-Water Heating in Residences and Other Buildings

DIRECT RADIATION†		SIZE OF FLUE	
STEAM (Sq. Ft.)	WATER (Sq. Ft.)	ROUND	SQUARE
250	400	8 in. diam.	8 x 8
300	500	8 in. diam.	8 x 8
400	700	8 in. diam.	8 x 8
500	850	10 in. diam.	8 x 12
600	1,000	10 in. diam.	8 x 12
700	1,200	10 in. diam.	8 x 12
800	1,350	12 in. diam.	12 x 12
900	1,500	12 in. diam.	12 x 12
1,000	1,700	12 in. diam.	12 x 12
1,200	2,100	12 in. diam.	12 x 12
1,400	2,400	14 in. diam.	12 x 16
1,600	2,700	14 in. diam.	12 x 16
1,800	3,000	14 in. diam.	12 x 16
2,000	3,400	14 in. diam.	12 x 16
2,200	3,700	16 in. diam.	16 x 16
3,000	5,100	16 in. diam.	16 x 16
3,500	5,900	18 in. diam.	16 x 20
5,000	8,500	18 in. diam.	16 x 20

†Note—When a considerable amount of "indirect" radiation is to be used, increased boiler capacity is necessary; and in many cases such demands require a larger chimney-flue for the same number of square feet of radiation used.

*"Practical Manual of Steam and Hot-Water Heating" by Edward Richmond Pierce.

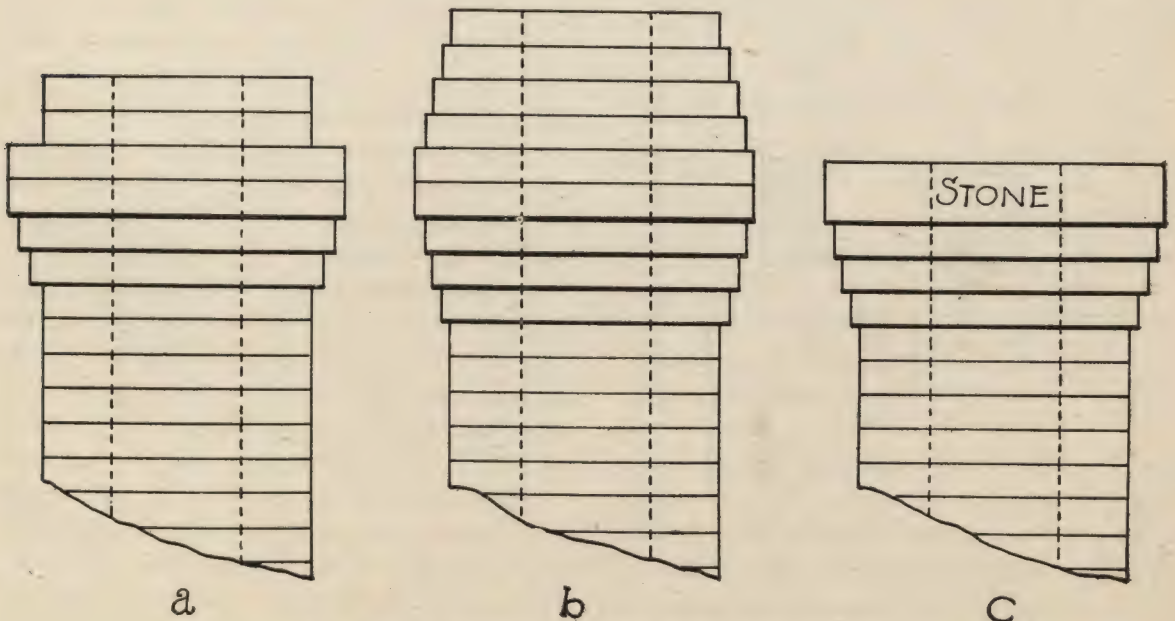


Fig. 121. Suggestions for Brick Chimney-Top Design.

are provided) are directly traceable to the chimney.

Aside from the outlet at the top, the chimney used with any heating apparatus should have no opening except that

pansion to overcome this pressure, when it will be forced upward by the circulation caused by opening a draft door below the grate of the heater.

Flues are built **round**, **square**, and **ob-**

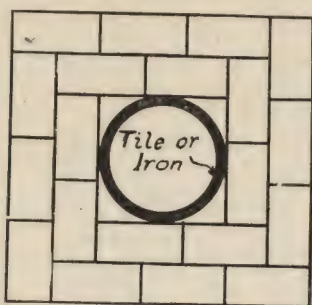


Fig. 122. Brick Flue with Round Tile or Iron Lining.

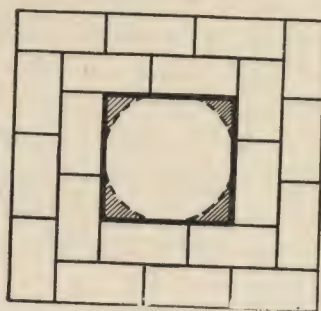


Fig. 123. Square Flue.

required to connect the smoke-pipe of the heater. This opening should conform in size to the smoke connection on the heater. As stated above, all manufacturers of furnaces, steam boilers, and hot-water heaters are careful to indicate the size of smoke connection best adapted to the use of a certain size of heater, **and this specified size should never be reduced.**

The flue should start but a few inches below the smoke-pipe opening, the part

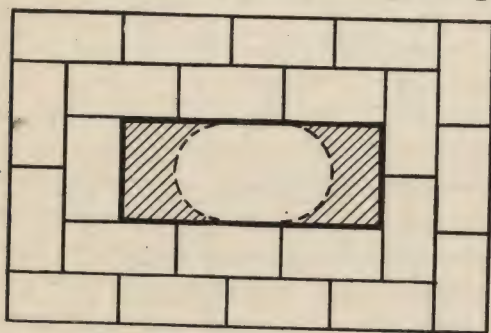


Fig. 124. Oblong Flue, Showing Large Proportion of Useless Space.

of the chimney beneath being constructed solid up to this point. Smoke, in ascending a flue, travels in a spiral form against the pressure of the atmosphere, and will not rise until the air in the flue is sufficiently lightened by ex-

long; and the degree of efficiency of the three different styles is indicated in the order named. A brick flue with a round tile or iron lining, as illustrated in Fig. 122, is, without doubt, the best that can be procured, as the heated gases and smoke occupy its full area. The next best type is the square flue, illustrated in Fig. 123. The dotted line indicates the area of the flue reserved by the smoke and gases, the shaded portion denoting the dead air-space. The illustration of the oblong flue, Fig. 124, shows these features also; and the reader will note the increased proportion of useless air-space in this type. This condition may be carried to such an extreme—as, for instance, with a flue 4 by 16 inches—that the amount of dead air-space will equal or even exceed that portion of the flue which is active surface, with the result that a down draft is produced, causing friction by mingling with the opposing current of air, and rendering the flue practically useless. A clear opening of an 8 by 8-inch flue, with an area of 64 square inches, would be far better and more efficient than a flue with an opening 4 by 24 inches, although the latter would have

an area of 96 square inches, or a capacity more than one-third greater.

A chimney erected through the cen-

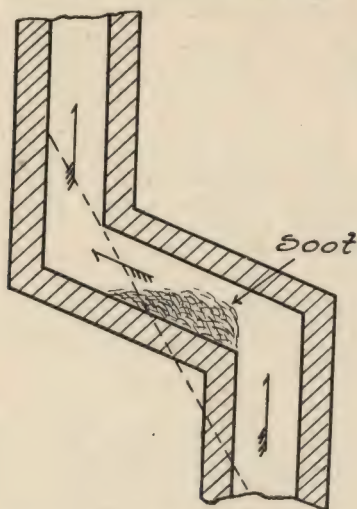


Fig. 125. Effect of Offsetting Flue at a Large Angle.

ter of a building is more efficient than one built in an outside wall, because it is surrounded by heated or warm rooms which in a large measure prevent the condensation of the smoke, the cooling of the gases, and the precipitation of soot. When constructed in an outside wall, the side of the chimney-flue exposed to the air should be at least 8 inches in thickness. In an outside chimney, the condensation of the smoke and gases from certain grades of coal will frequently cause the sulphur and creosote ingredients to run down the chimney into the smoke-pipe, by this action causing its rapid destruction. These products of combustion leave a dry deposit, which hardens to the consistency of iron, clogging the dampers in the smoke-pipe or in the smoke-hood of the heater.

Offsetting of chimney flues should, if possible, invariably be avoided. If conditions, however, make such a construction absolutely necessary, the an-

gle of the offset should be as sharp as possible, otherwise the soot and ashes will form a deposit in the offset and

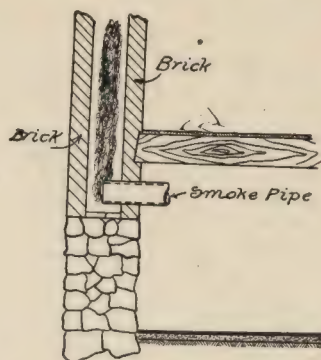


Fig. 126. A Common Cause of Poor Draft—Smoke-Pipe Extending Too Far into Flue Opening.

clog up the flue. Fig. 125 illustrates this, and shows by dotted line how offset should have been made.

Height in a flue simply governs velocity, having no effect whatever on the area, which should be sufficient for the work demanded of it. A chimney in a

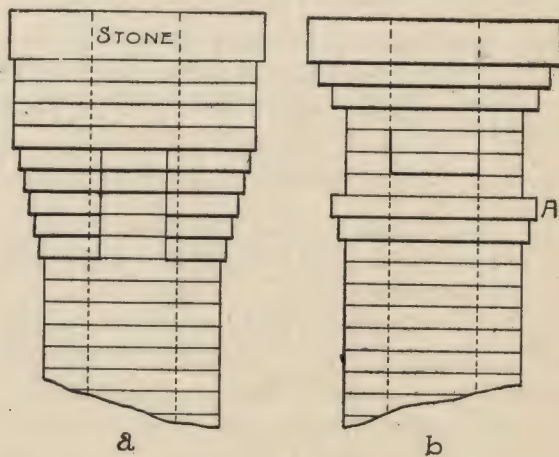


Fig. 127. Brick Chimney-Tops.

building of two or more stories has sufficient height to be suitable for all purposes. It should extend above the building to such a distance that adja-

cent structures or roofs will not interfere with its working, or cause a possible down draft by reason of the wind blowing over the roof and down through the chimney.

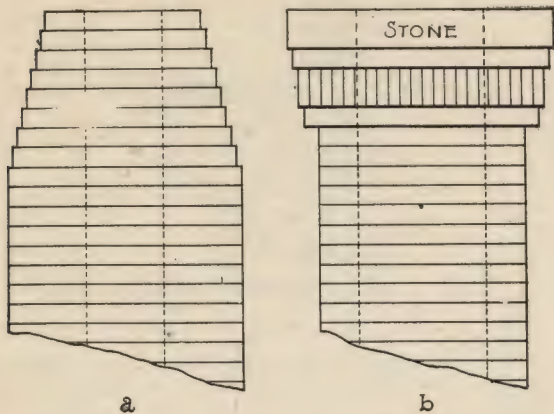


Fig. 128. Brick Chimney-Tops.

Trouble with the draft in a heating system may be due to any one of the following causes:

- 1. Obstructions in flue, such as extensions of bricks or timbers, or an extension of smoke-pipe too far into flue opening, as shown in Fig. 126.
- 2. Loose or open clean-out doors at base of chimney.
- 3. Height insufficient to clear surrounding obstructions to draft.
- 4. Insufficient area for work demanded of flue.
- 5. An enlarged or contracted chimney at some point in its length. A flue is only as large as the area at its smallest portion.
- 6. Two or more smoke-pipes from different apparatus connected to same chimney, one working against another.
- 7. Offsets at too great an angle—that is, too flat.
- 8. Loose division walls between flues one of which is used for the heater.

These are the causes of some of the difficulties commonly experienced with chimneys, and their enumeration should prove a valuable aid in locating any possible trouble. As a guide to follow in the proper construction of a chimney, Table XXXI is given, which shows the proper sizes of brick and tile flues for different-sized buildings. The dimensions of tile given are commercial sizes. The capacities scheduled

TABLE XXXI
Sizes of Chimney Flues for Different-Sized Buildings

CAPACITY OF BUILDING (Cu. Ft.)	BRICK	TILE, SQUARE (OUTSIDE DIMENSIONS)	TILE, ROUND (INSIDE DIMENSIONS)
Up to 20,000	8x12 in.	8½x13½ in.	10 in.
20,000 to 40,000	12x12 in.	13 x13 in.	12 in.
40,000 to 70,000	12x16 in.	13 x18 in.	15 in.
70,000 to 100,000	16x16 in.	18 x18 in.	18 in.
100,000 to 150,000	16x24 in.	.....	.....
150,000 to 250,000	24x24 in.	.....	.....

Square tile for flue linings are sized and listed commercially from outside dimensions; round tile, from inside dimensions.

have been found in practice to be entirely sufficient for ordinary work, and can be safely relied upon to render proper results.

Brick Quality and Heating Plant Efficiency. It has been calculated that the average room, with doors and windows shut, will change its air at least once an hour through ordinary air-leakage. In winter-time and the cold weather of the early spring and late fall, the whole house resembles the room in that it affords by leakage constant opportunity for heat losses. Thousands of heat-units are lost each hour by way of the walls, windows, floors, ceilings, and fireplace.

The wall heat-loss is quite important, and the choice of the material of which the wall is constructed should be made wisely. There is not much difference, in loss of heat, between a well-built wooden wall well papered and clapboarded, a waterproofed concrete wall, a stone wall, a properly constructed stucco wall, a brick-veneered wall, and a wall composed of properly laid hard building brick. There is not so much difference between any or all of these as there can be found between two brick walls. We

TABLE XXXII
Heat Losses in Brick Walls

THICKNESS OF WALL	B. T. U. PER SQ. FT. PER DEG. OF DIFFERENCE	OUTSIDE WALL, B.T. U. PER SQ. FT. PER HOUR
1 Brick	0.357	25
1½ Bricks	0.286	20
2 Bricks	0.243	17
2½ Bricks	0.214	15
3 Bricks	0.186	13

Approximate loss of heat through walls when outside air is zero, inside air 70 deg., per sq. ft. per hr. in B. T. U. Wall plastered on one side. No wind blowing. Building continuously heated day and night.

have seen that a fine, hard brick will not absorb more than 5 per cent moisture, and that what is known as a good brick will not take up more than 10 per cent. Inferior brick will absorb from 25 to 40 per cent of their weight in water.

The reader must bear in mind that water is the greatest absorber of heat known; that one heat-unit is the amount of heat required to raise one pound of water one degree of temperature, and that same amount of heat will raise five pounds of dry masonry one degree. Let the masonry absorb from 15 to 30 per cent of moisture, and it will be readily understood that the heating plant will be called upon to work overtime to keep the house warm and dry during wet and chilly weather. Short-sighted home-builders will pay a high price for a face-brick front, and will then endeavor to clip off a few dollars by buying the cheapest brick possible for the sides and the rear of the building. Fully 70 per cent of the wall exposure of the house is in this way constructed of an absorbent brickwork, with its attendant liabilities to mortar-joint defects. The weakest wall surface of this kind is often the one

that has the most unfavorable wind and weather exposure.

Table XXXII, compiled by E. R. Pierce, in his "Practical Manual of Steam and Hot-Water Heating," offers for consideration some interesting figures on heat loss through brick walls.

This loss is noted when there is no wind. To give the reader some conception of wind effect on heat loss, in a brief paragraph we shall note the wind velocity and corresponding heat loss in B. T. U. per sq. ft. per hour on a one-brick wall, with a loss of 25, as shown in the table. With a wind-velocity of 2 miles per hr., the loss is increased to 25.5; 5 miles, 26.25; 10 miles, 27.50; average winter wind with velocity of 12½ miles per hr., loss is 28.12; 15 miles, 28.75; 20 miles, 30.00; 30 miles, 32.50. Thus it may be calculated that with a 2-brick wall and 125 sq. ft. of exposed surface, there will be a loss of 2,390 B. T. U. per hour from the wall.

A few dollars saved in the purchase of brick of inferior quality, or through neglect in noting the absorptive quality of the brick selected, will be attended later by fuel-expense and lack of comfort. Buy good brick. They pay dividends.

Bricknogging. To prevent the passage of vermin and also to offer resistance to fire, it is often specified that a course of brick shall be built in at the bottom of the story and also at half the height, resting on the bridging. This brickwork in wooden partitions is known as **bricknogging**. The brick must not be wider than the studs or the lathing will not nail on straight. The bricknogging should be built from the top of the partition to the top of the joist when the joist rests on the partition.

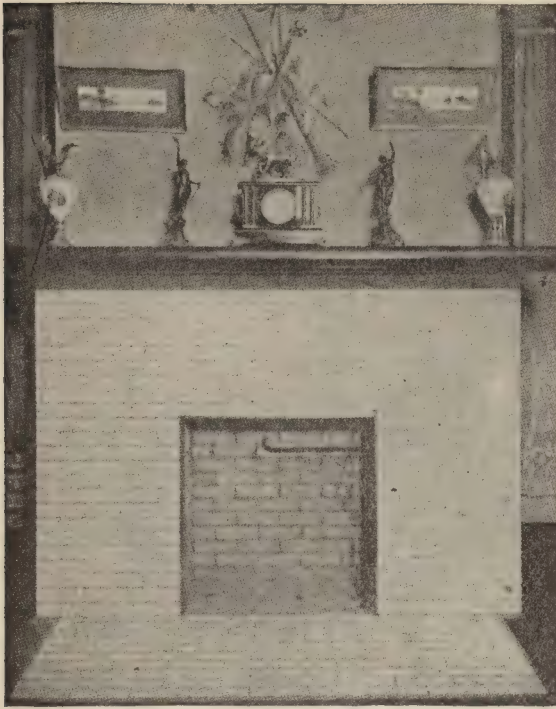


Fig. 129. First Fireplace Constructed of Glass Brick.

Glass Brick. A combination of glass and concrete has recently been developed for construction work, in the shape of brick consisting of glass molded in various hollow shapes, or of glass facings with concrete backing.



Fig. 130. Forms for Casting Glass Bricks.

Forms for casting these brick are shown in Fig. 130. Fig. 131 shows the method of pouring them full of concrete, also one manner of laying them in wall construction.

The brick have indented ends, and may be laid up with narrow mortar joints if desired. Good practice demands the making of a full mortar

joint to prevent contact of the glass edges under undue pressure.

Glass brick are bonded to courses of other material in the same manner used in pressed-brick work, by metallic tees or headers. All colors of which glass is capable can be produced in glass brick. Bricklayers handling this product should be enjoined against undue hammering of the brick when placing them in the wall. The brick may be cracked by so doing. If laid perfect in the wall, they will remain so, being impervious to all temperature and moisture changes. In the glass-faced brick, the cement of the concrete adheres to the glass; and a dovetailed rib of glass traverses the entire length of the back of the facing, making a very effective bond.

Figs. 129 and 132 show glass brick used for a fireplace and a swimming pool respectively. For swimming pools, cisterns, etc., these brick are claimed to be especially serviceable. The brick proper need not be concrete-filled. They can remain hollow to remove surface seepage.

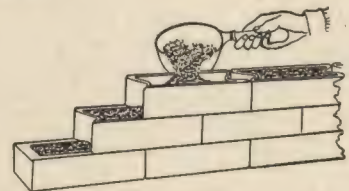


Fig. 131. Pouring Glass Brick. Showing also method of wall construction.

Hollow Brick. Hollow brick are often used for backing brick and for damp courses. They are the same size as the ordinary brick, and therefore bond readily in the wall. They are laid so that the openings run through the wall when serving as damp courses, to allow ventilation and evaporation.

Vitrified Clay Conduits. These are specifically made for the laying and insulating of electrical cables and wires. They are exceptionally strong, being vitrified, and are being used with success for the foundation and inside walls of stucco houses. They are made 1-way, 2-way, or with multiple passages, and square, oblong, or triangular as desired.

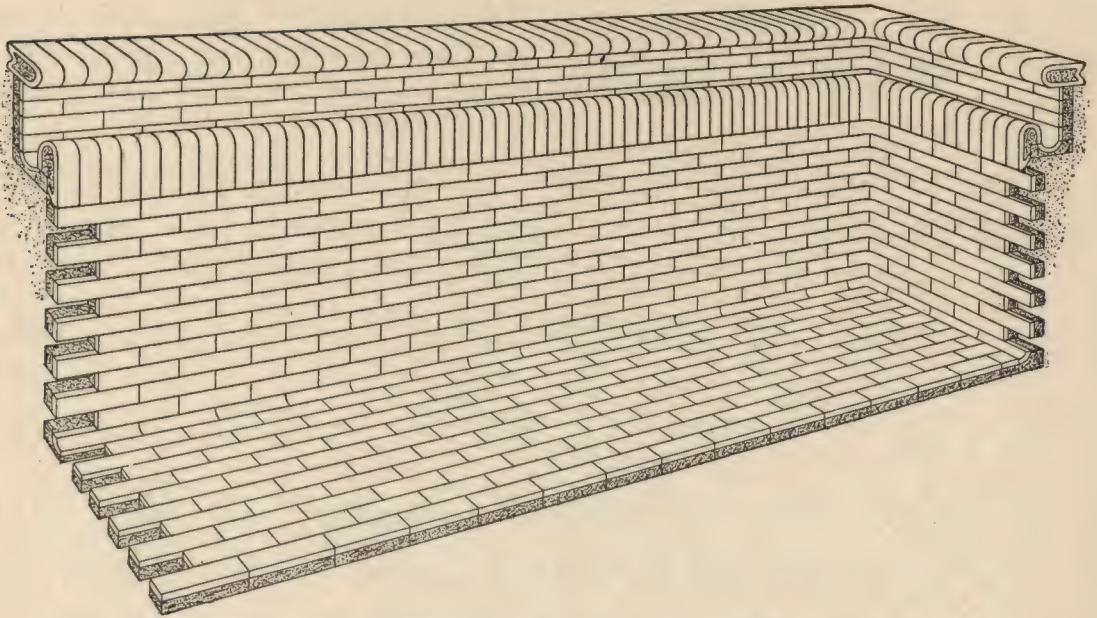


FIG. 132. PART DETAIL OF SWIMMING TANK LINED WITH GLASS BRICK.

Reinforced Brickwork. The pioneer of reinforced brickwork was Cottancin, a French engineer. More recently the claims of reinforced brickwork have been advocated by

ings. The latest application of the same principle is exemplified by various river and canal banks in France, which are faced with reinforced brickwork, as illustrated in Figs. 133 and 134. The bricks are pierced by two holes for galvanized or copper wires, and are set as follows:

The slope to be protected is finished to the required gradient, and the reinforcing wires

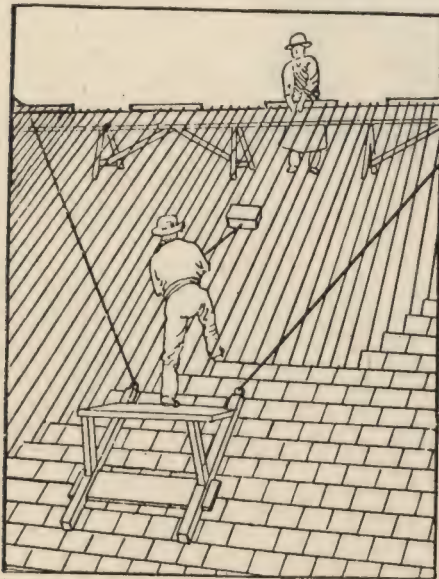


Fig. 133. Method of Laying Reinforced Brick Slope.

two or three specialist firms, and used with considerable advantage in the construction of walls and floors in industrial and other build-

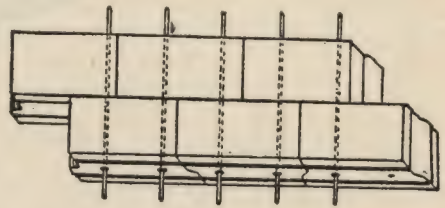
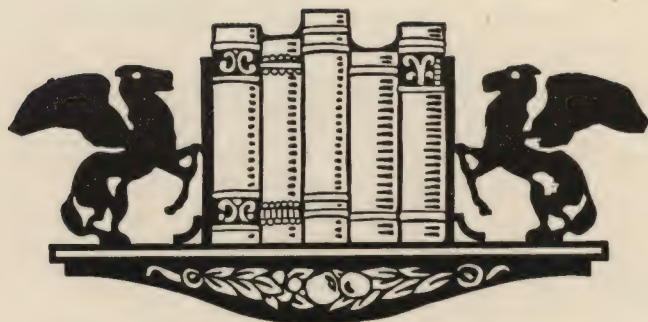


Fig. 134. Detail of Reinforced Brickwork.

are secured to a cable stretched along the bottom of the slope. The free end of each wire is then attached to a horizontal frame at the top of the slope, where the bricks are threaded on the wires and slid down to the bricklayers. When the work has passed beyond reach from ground level, the layers stand upon a small platform, as shown in Fig. 133; and, on completion of the facing, the upper ends of the wires are securely anchored.

Size of a Brick Hod. A brick hod measures from 20 to 22 in. in length, and 8 in. on the sides. Its load is from 16 to 20 brick.

Size of a Mortar Hod. The average length of a mortar hod is about 22 in. in length, and its depth on the sides ranges from 12 to 14 in.



PART II—MODEL DESIGNS OF BRICK HOUSES

Perspectives and floor plans of Brick Residences both large and small, Brick Bungalows, Brick Store and Flat Buildings, Brick Churches, Brick Schools and other Public Buildings.

Designs show use of Brick in combination with Cement Stucco, Board Siding, Shingles, Stone, etc.

The architects' perspective drawings and the photographs make clear exactly how these buildings will appear when completed; you don't have to wait till your money is spent and the workmen have finished before knowing whether your new home is really what you want, or not, after all. You don't have to depend on some architect's or builder's word for it if you choose

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Study the floor plans; you will find all room sizes plainly marked. These rooms have all been laid out by experts to save steps in doing the house work. You will find them comfortably convenient, and thoroughly modern in their arrangement.

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Foundation and Cellar Plans This sheet shows the shape and size of all the walls, piers, footings, posts, etc., and of what materials they are constructed; shows the location of all windows, doors, chimneys, ash-pits, partitions, and the like. The different wall sections are given, showing their construction and measurements from all the different points.

Floor Plans These plans show the shape and size of all rooms, halls and closets; the location and size of all doors and windows; the position of all plumbing fixtures, gas lights, registers, pantry work, etc., and all the measurements that are necessary are given.

Elevations A front, right, left and rear elevation are furnished with all the plans. These drawings are complete and accurate in every respect. They show the shape, size and location of all doors, windows, porches, cornices, towers, bays, and the like; in fact, give you an exact scale picture of the house as it should be at completion. Full wall sections are given, showing the construction from foundation to roof, the height of stories between the joists, height of plates, pitch of roof, etc.

Roof Plan This plan is furnished where the roof construction is at all intricate. It shows the location of all hips, valleys, ridges, decks, etc. All the above drawings are made to scale one-quarter inch to the foot.

Details All necessary details of the interior work, such as door and window casings and trim, base, stools, picture moulding, doors, newel posts, balusters, rails, etc., accompany each set of plans. Part is shown in full size, while some of the larger work, such as stair construction, is drawn to a scale of one and one-half inch to the foot. These blue-prints are substantially and artistically bound in cloth and heavy water-proof paper, making a handsome and durable covering and protection for the plans.

Specifications The specifications are typewritten on Lakeside Bond Linen paper, and are bound in the same artistic manner as the plans, the same cloth and water-proof paper being used. They consist of twenty-two pages of closely typewritten matter, giving full instructions for carrying out the work. All necessary directions are given in the clearest and most explicit manner, so that there can be no possibility of a misunderstanding.

Basis of Contract The working plans and specifications we furnish can be made the basis of contract between the home builder and the contractor. This will prevent mistakes, which cost money, and they will prevent disputes which are unforeseen and never settled satisfactorily to both parties. When no plans are used the contractor is often obliged to do some work he did not figure on, and the home builder often does not get as much for his money as he expected, simply because there was no basis on which to work and upon which to base the contract.

No Misunderstanding Can Arise when a set of our plans and specifications is before the contractor and the home builder, showing the interior and exterior construction of the house as agreed upon in the contract. Many advantages may be claimed for the complete plans and specifications. They are time savers, and, therefore, money savers. Workmen will not have to wait for instructions when a set of plans is left on the job. They will prevent mistakes in cutting lumber, in placing door and window frames, and in many other places where the contractor is not on the work and the men have received only partial or indefinite instructions. They also give instructions for the working of all material to the best advantage.

Free Plans for Fire Insurance Adjustment You take every precaution to have your house covered by insurance; but do you make any provision for the adjustment of the loss, should you have a fire? There is not one man in ten thousand who will provide for this embarrassing situation. You can call to mind instances in your own locality where settlements have been delayed because the insurance companies wanted some proof which could not be furnished. They demand proof of loss before paying insurance money, and they are entitled to it. We have provided for this and have inaugurated the following plan, which cannot but meet with favor by whoever builds a house from our plans.

Immediately Upon Receipt of Information from you that your house has been destroyed by fire, either totally or partially, we will forward you, free of cost, a duplicate set of plans and specifications, and in addition we will furnish an affidavit giving the number of the design and the date when furnished, to be used for the adjustment of the insurance.

Without One Cent of Cost to You and without one particle of trouble. We keep a record of the number of the house design and the date it was furnished, so that, in time of

loss, all it will be necessary for you to do is to drop us a line and we will furnish the only reliable method of getting a speedy and satisfactory adjustment. This may be the means of saving you hundreds of dollars, besides much time and worry.

Our Liberal Prices Many have marveled at our ability to furnish such excellent and complete working plans and specifications at such low prices. We do not wonder at this, because we charge but \$10.00 and up for a more complete set of working plans and specifications than you would receive if ordered in the ordinary manner, and when drawn especially for you, at a cost of from seventy-five to five hundred dollars. On account of our large business and unusual equipment, and owing to the fact that we divide the cost of these plans among so many, it is possible for us to sell them at these low prices. The margin of profit is very close, but it enables us to sell thousands of sets of plans, which save many times their cost to both the owner and the contractor in erecting even the smallest dwelling.

Our Guarantee Perhaps there are many who feel that they are running some risk in ordering plans at a distance. We wish to assure our customers that there is no risk whatever. If, upon receipt of these plans you do not find them exactly as represented, if you do not find them complete and accurate in every respect, if you do not find them as well prepared as those furnished by any architect in the country, or any that you have ever seen, we will refund your money upon the return of the plans from you in perfect condition. All of our plans are prepared by architects standing at the head of their profession, and the standard of their work is the very highest. We could not afford to make this guarantee if we were not positive that we were furnishing the best plans put out in this country even though our price is not more than one-seventh to one-tenth of the price usually charged.

Bill of Material We do not furnish a bill of material. We state this here particularly, as some people have an idea that a bill of material should accompany each set of plans and specifications. In the first place our plans are gotten up in a very comprehensive manner, so that any carpenter can easily take off the bill of material without any difficulty. We realize that there are hardly two sections of the country where exactly the same kinds of materials are used and, moreover, a bill which we might furnish would not be applicable in all sections of the country. We furnish plans and specifications for houses which are built as far north as the Hudson Bay and as far south as the Gulf of Mexico. They are built upon the Atlantic and Pacific Coasts, and you can also find them in Australia and South Africa. Each country and section of a country has its peculiarities as to size and qualities; therefore, it would be useless for us to make a list that would not be universal. Our houses, when completed, may look the same whether they are built in Canada or Florida, but the same materials will not be used, for the reason that the customs of the people and the climatic conditions will dictate the kind and amount of materials to be used in their construction.

Estimated Cost It is impossible for anyone to estimate the cost of a building and have the figures hold good in all sections of the country. We do not claim to be able to do it. The estimated cost of the houses we illustrate is based on the most favorable conditions in all respects, and includes everything but the plumbing and heating. We are not familiar with your local conditions, and, should we claim to know the exact cost of a building in your locality, a child would know that our statement was false. We leave this matter in the hands of the reliable contractors. for they, and they alone, know your local conditions.

We Wish to be Frank With You and therefore make no statement that we cannot substantiate in every respect. If a plan in this book pleases you; if the arrangement of the rooms is satisfactory, and if the exterior is pleasing and attractive, then we make this claim—that it can be built as cheaply as if any other architect designed it, and we believe cheaper.

We Have Studied Economy in construction, and our knowledge of all the material that goes into a house qualifies us to give you the best for your money. We give you a plan that pleases you, one that is attractive, and one where every foot of space is utilized at the least possible cost. Can any architect do more, even at seven to ten times the price we charge you for plans?

Reversing Plans We receive many requests from our patrons for plans exactly according to the designs illustrated, with the one exception of having them reversed or placed in the opposite direction. It is impossible for us to make this change and draw new plans, except at a cost of about eight times our regular price. We see no reason why our regular plans will not answer your purpose. Your carpenter can face the house exactly as you wish it, and the plans will work out as well facing in one direction as in another. We can, however, if you wish, and so instruct us, make you a reversed blue-print and furnish it at our regular price; but in that case all the figures and letters will be reversed, and, therefore, liable to cause as much confusion as if your carpenter reversed the plan himself while constructing the house.

We Would Advise however, in all cases where the plan is to be reversed, and there is the least doubt about the contractor not being able to work from the plans as we have them, that two sets of blue-prints be purchased, one regular and the other reversed, and in such cases we will furnish two sets of blue-prints and one set of specifications for only fifty per cent added to the regular cost, making the \$10.00 plan cost only \$15.00.

Immediate Delivery Guaranteed Our equipment and facilities are such that we can send out the same day we receive order the complete plans and specifications for any house we illustrate. Delivery is made by express whenever possible, otherwise plans and specifications are forwarded by mail.

PUBLISHED BY

The Radford Architectural Co.

178 W. Jackson Boulevard, Chicago, Illinois



Design No. 9535

Size: Width, 37 feet; Length, 28 feet

Blue prints consist of base-ment plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

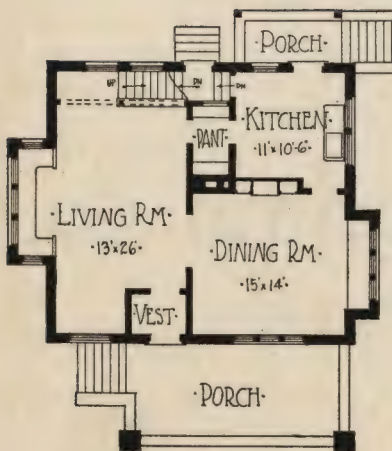
PRICE

of Blue Prints, together with a complete set of typewritten specifications

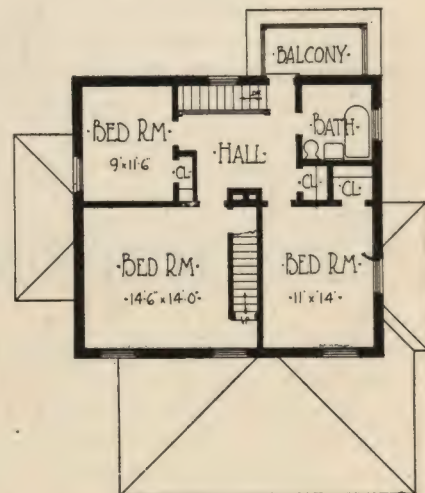
ONLY

\$34.00

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First Floor Plan



Second Floor Plan

EXCHANGING PLANS. If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.



Design No. 9508

Size: Width, 29 feet; Length, 50 feet 6 inches

Blue prints consist of basement plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

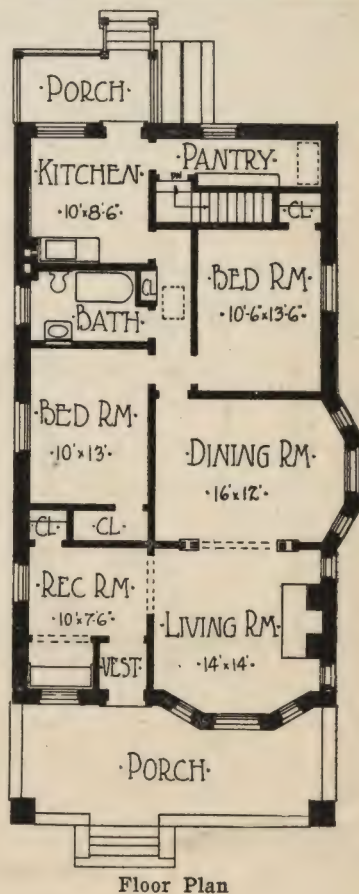
of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$18.00

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ESTIMATED COST. A schedule of costs is given on page 219.
See also preface page 130.





Design No. 9528

Size: Width, 28 feet, 6 inches; Length, 34 feet

Blue Prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

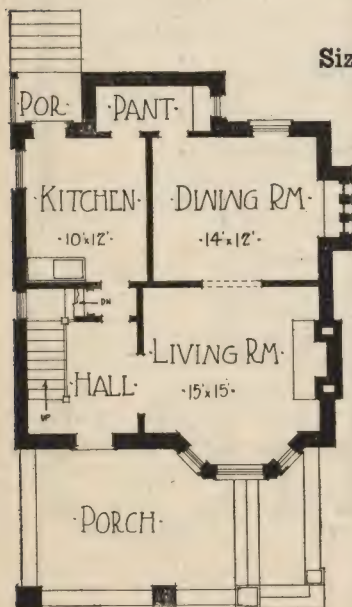
PRICE

of Blue Prints, together with a complete set of typewritten specifications

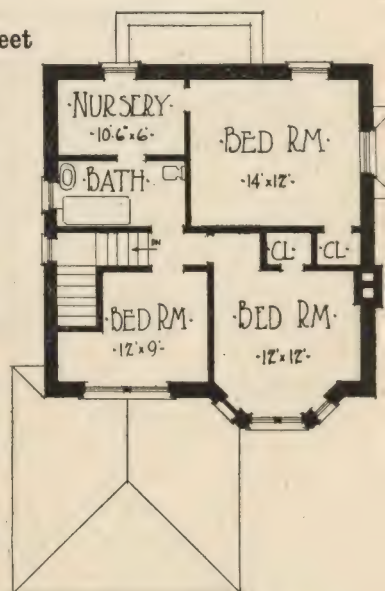
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First Floor Plan



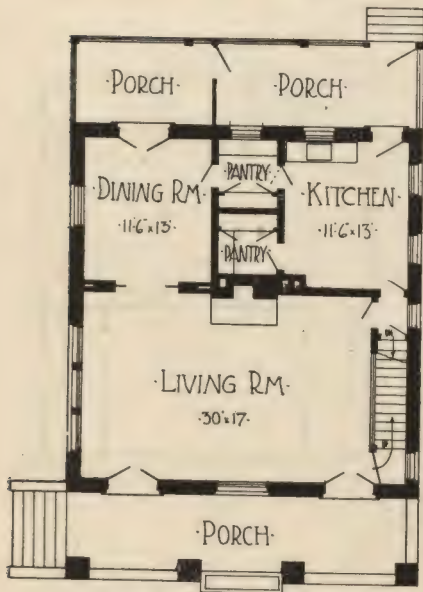
Second Floor Plan

ALTERATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.



Design No. 9518

Size: Width, 32 feet 6 inches; Length, 33 feet 6 inches



First Floor Plan

Blue prints consist of cellar plan; floor plan; attic plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

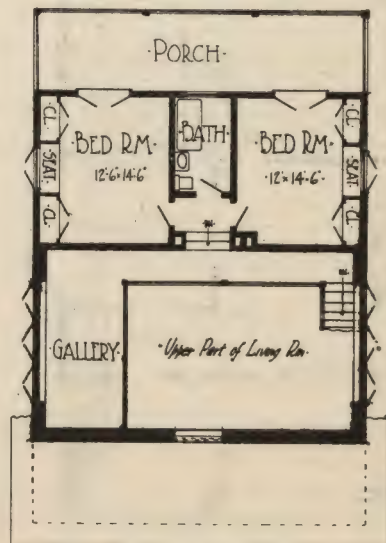
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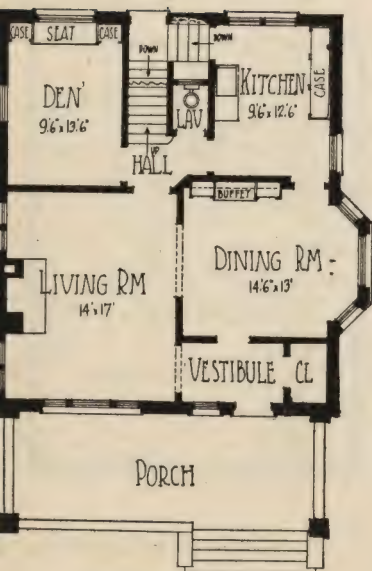
Second Floor Plan

ALTERATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.



Design No. 9532

Size: Width, 31 feet; Length, 33 feet



First Floor Plan

Blue prints consist of base-
ment plan; roof plan; first and
second floor plans; front, rear,
two side elevations; wall sections
and all necessary interior details.
Specifications consist of twenty-
two pages of typewritten matter.

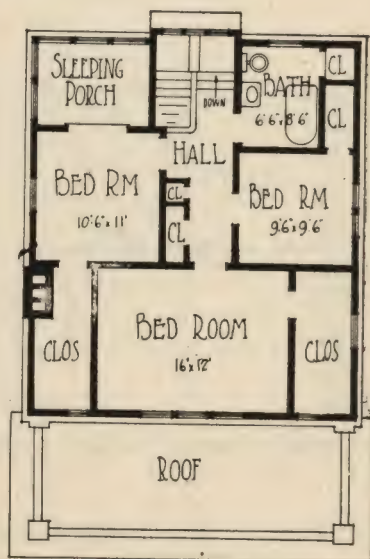
PRICE

of Blue Prints, together with a
complete set of typewritten
specifications

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tions the same day order is re-
ceived.



Second Floor Plan

EXCHANGING PLANS. If returned in good condition within 30 days we will exchange any set of
plans, applying full price on any other set desired.



Design No. 9519

Size: Width, 28 feet; Length, 48 feet

Blue prints consist of basement plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

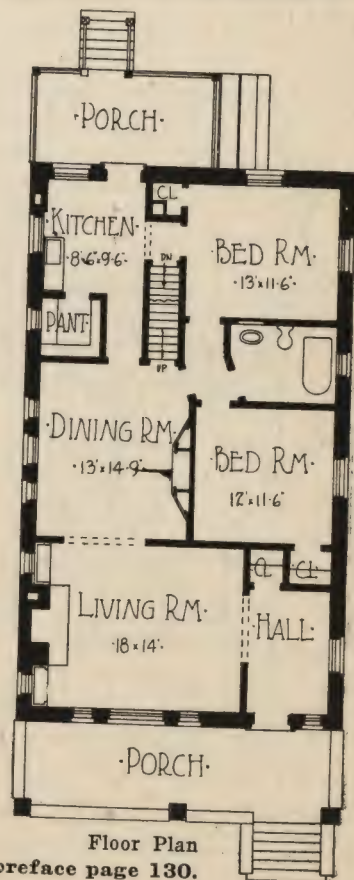
PRICE

of Blue Prints, together with a complete set of typewritten specifications

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\$22.00

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ESTIMATED COST. A schedule of costs is given on page 219. See also preface page 130.



Design No. 9557

Size: Width, 38 feet; Length, 44 feet



First Floor Plan

Blue Prints consist of base-ment plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

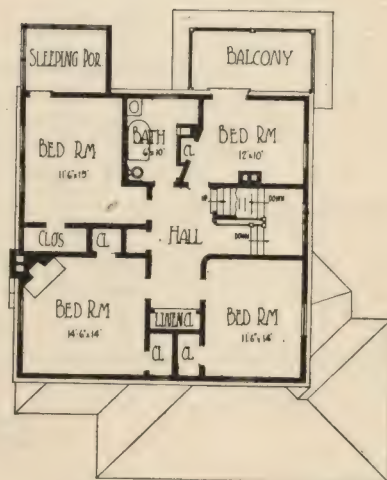
PRICE

of Blue Prints, together with a complete set of typewritten specifications

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Second Floor Plan

MODIFICATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.



Design No. 9521

Size: Width, 31 feet 6 inches; Length, 51 feet

Blue prints consist of cellar and foundation plan; roof plan; first floor plan; front, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

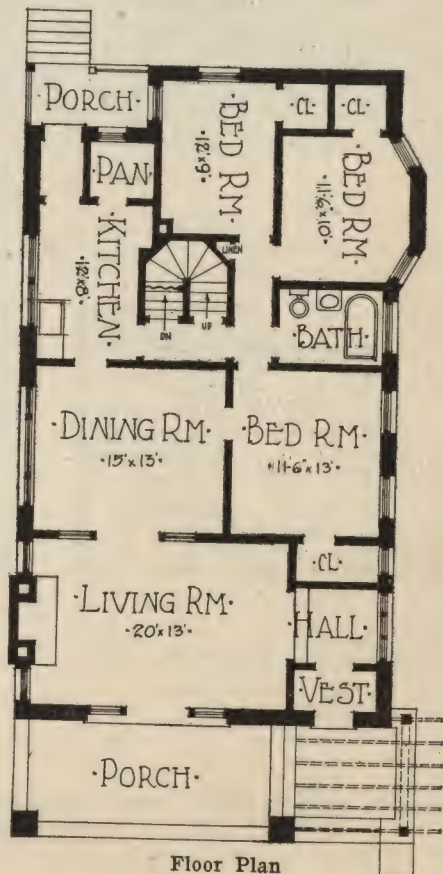
of Blue Prints, together with a complete set of typewritten specifications

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\$24.00

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ESTIMATED COST. A schedule of costs is given on page 219.
See also preface page 130.



Floor Plan



Design No. 9554

Size: Width, 42 feet; Length, 41 feet



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

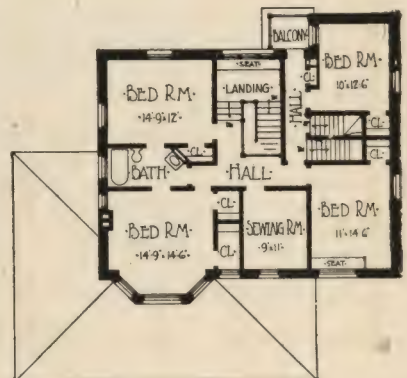
PRICE

of Blue Prints, together with a complete set of typewritten specifications

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Second Floor Plan

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Design No. 9533

Size: Width, 32 feet 6 inches; Length, 33 feet



First Floor Plan

ESTIMATED COST. A schedule of costs is given on page 219. See also preface page 130.

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

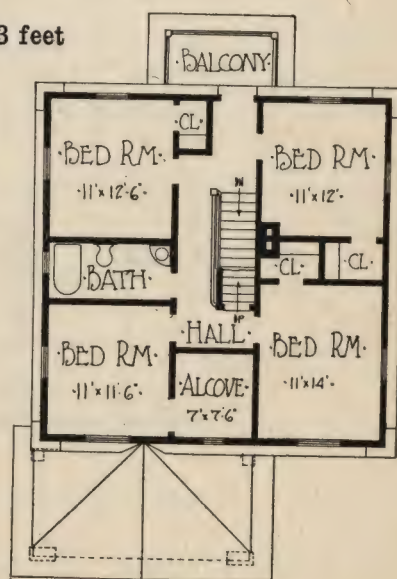
PRICE

of Blue Prints, together with a complete set of typewritten specifications,

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Second Floor Plan



Design No. 9534

Size: Width, 45 feet; Length, 25 feet

Blue Prints consist of basement plan; roof plan; first and second floor plans; front, rear, and two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

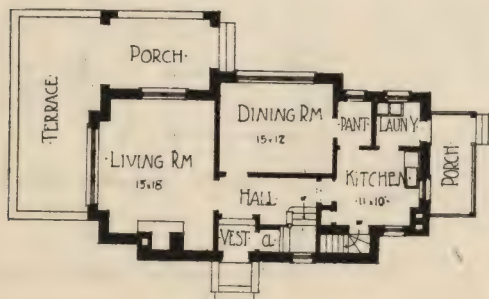
PRICE

of Blue Prints, together with a complete set of typewritten specifications,

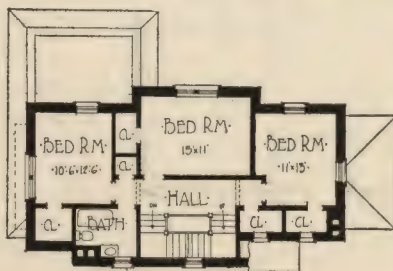
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First Floor Plan



Second Floor Plan

EXCHANGING PLANS. If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.



Design No. 9515

Size: Width, 47 feet 6 inches; Length, 46 feet

Blue prints consist of basement plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of type-written matter.

PRICE

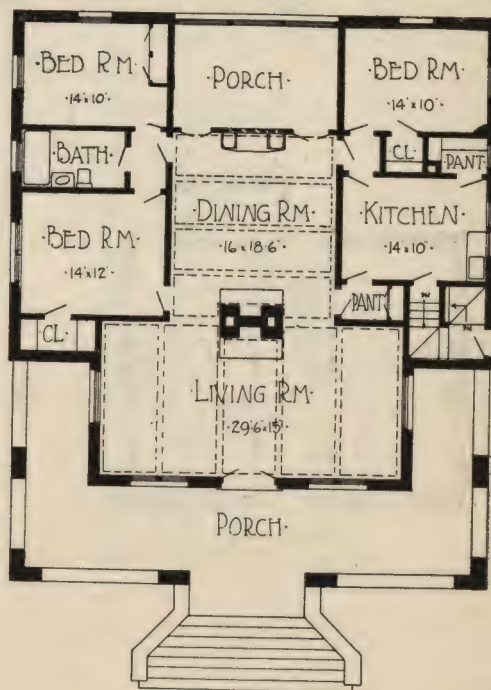
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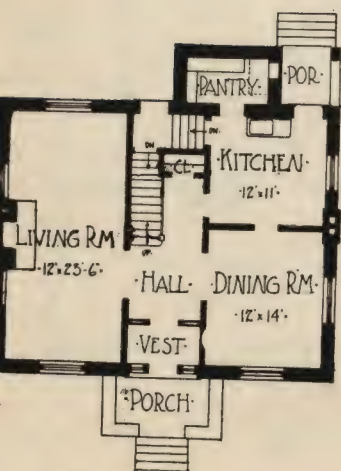


Floor Plan



Design No. 9548

Size: Width, 35 feet; 6 inches; Length, 34 feet



First Floor Plan

Blue prints consist of base-ment plan; roof plan; first and second floor plans; front, rear and two side elevations; wall sections and all neces-sary interior details. Specifi-cations consist of twenty-two pages of typewritten matter.

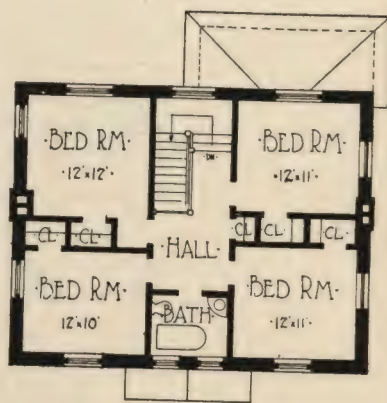
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

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Second Floor Plan

EXCHANGING PLANS. If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.



Design No. 9549

Size: Width, 39 feet; Length, 33 feet

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

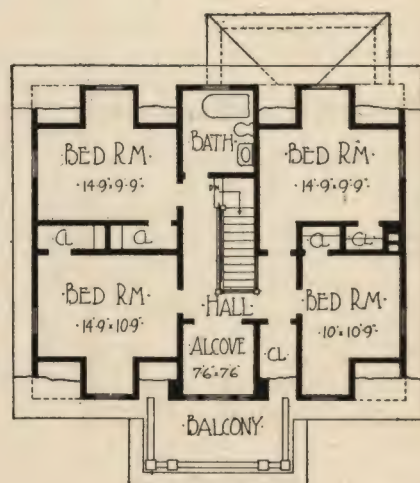
ONLY

\$40.00

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First Floor Plan



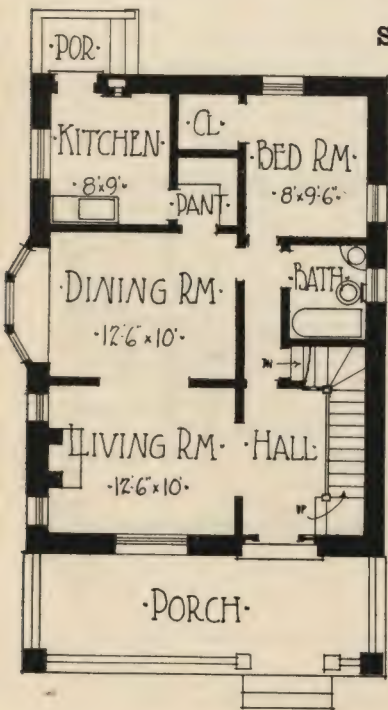
Second Floor Plan

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Design No. 9501

Size: Width, 26 feet; Length, 32 feet 6 inches



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

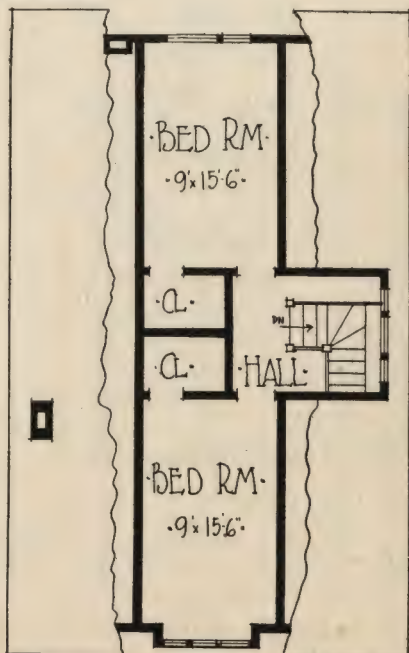
PRICE

of Blue Prints, together with a complete set of typewritten specifications

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Second Floor Plan



Design No. 9529

Size: Width, 26 feet; Length, 37 feet

Blue prints consist of base-ment plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

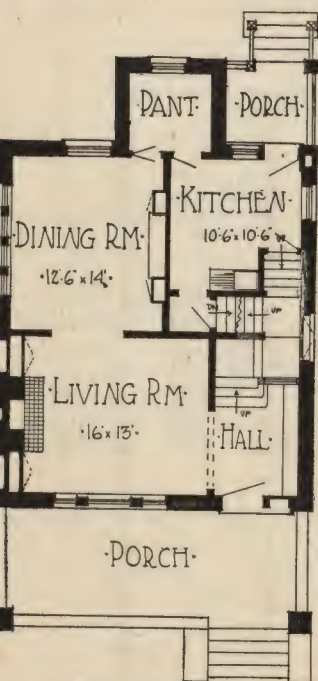
PRICE

of Blue Prints, together with a complete set of typewritten specifications

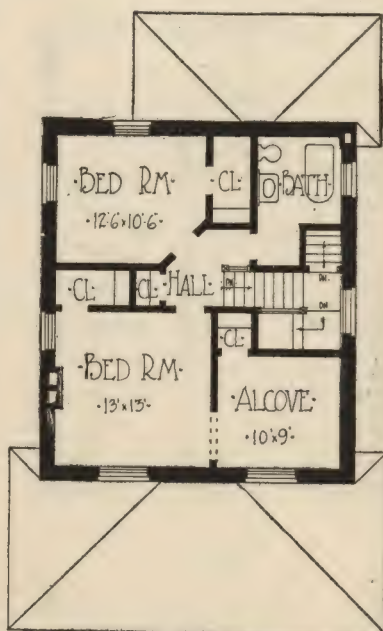
ONLY

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First Floor Plan



Second Floor Plan

ESTIMATED COST. A schedule of costs is given on page 219. See also preface page 130.



Design No. 9512

Size: Width, 32 feet; Length, 49 feet 6 inches

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

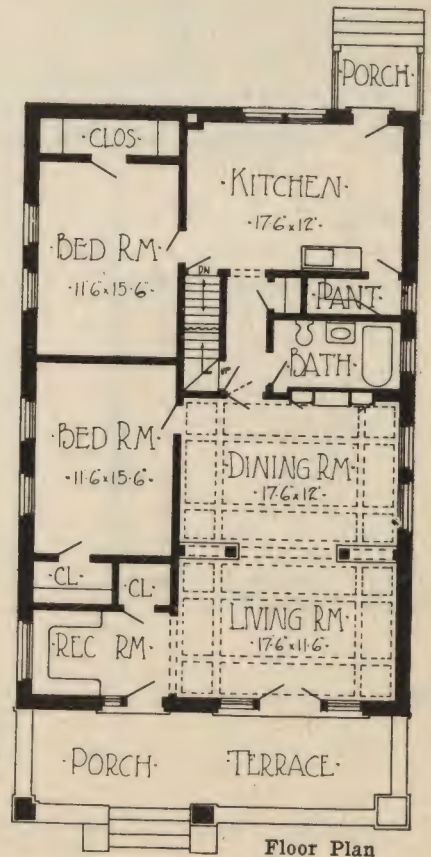
of Blue Prints, together with a complete set of typewritten specifications

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Design No. 9524

Size: Width, 31 feet; Length, 27 feet

Blue prints consist of cellar and foundation plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

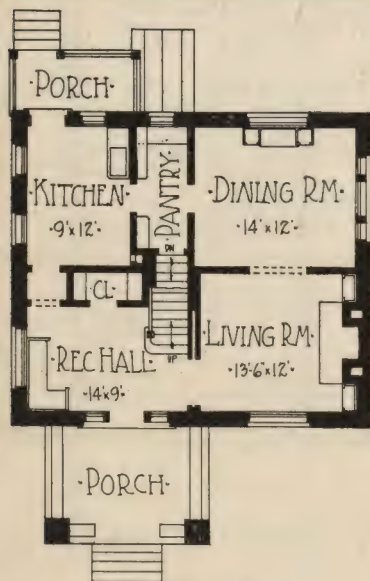
PRICE

of Blue Prints, together with a complete set of typewritten specifications

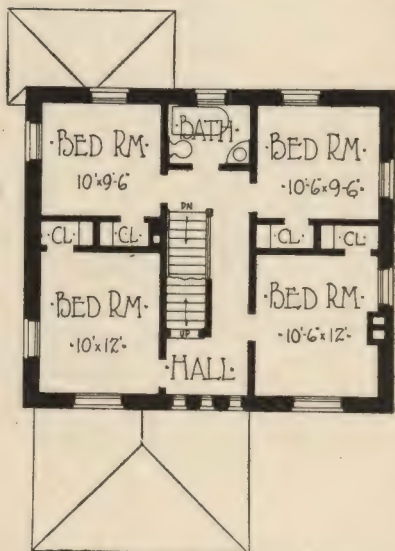
ONLY

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First Floor Plan



Second Floor Plan

ALTERATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.



Design No. 9510

Size: Width, 30 feet; Length, 39 feet 6 inches

Blue prints consist of basement plan; roof plan; floor plan; front, rear, and two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

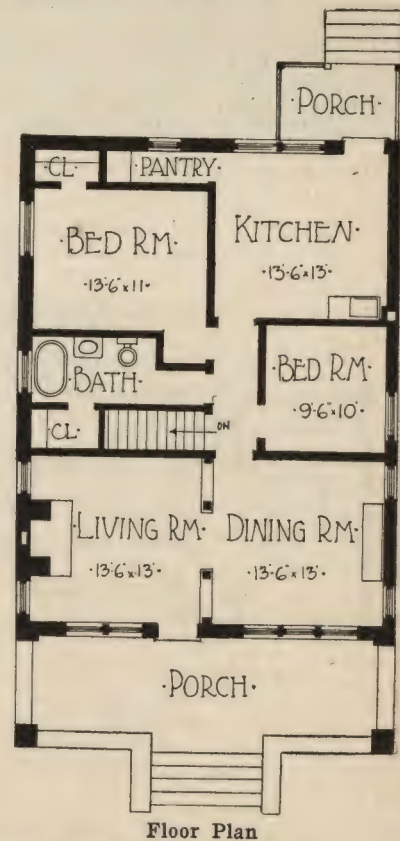
PRICE

of Blue Prints, together with a complete set of typewritten specifications

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\$18.00

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ESTIMATED COST. A schedule of costs is given on page 219. See also preface page 130.



Design No. 9542

Size: Width, 44 feet; Length, 30 feet

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications.

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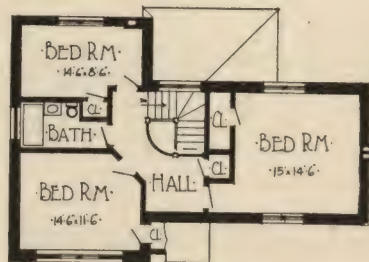
\$36.00

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First Floor Plan

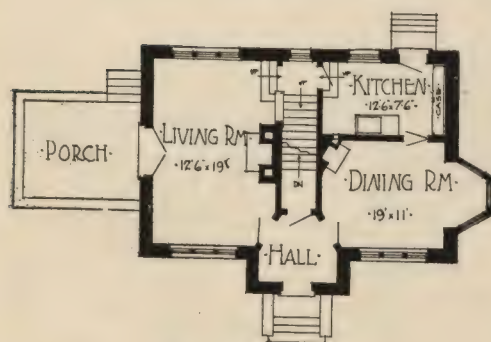


Second Floor Plan

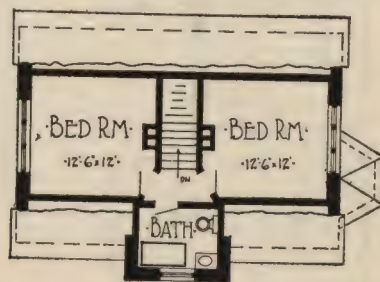


Design No. 9526

Size: Width, 36 feet; Length, 25 feet 6 inches



First Floor Plan



Second Floor Plan

PRICE

of Blue Prints, together with a complete set of type-written specifications

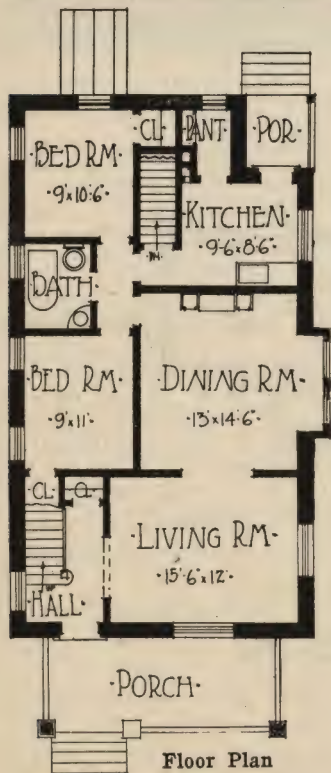
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Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of type-written matter.

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Design No. 9503

Size: Width, 26 feet 6 inches; Length, 44 feet 6 inches

Blue prints consist of cellar and foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$16.00

We mail Plans and Specifications the same day order is received.

ESTIMATED COST. A schedule of costs is given on page 219. See also preface page 130.



Design No. 9527

Size: Width, 36 feet; Length, 26 feet 6 inches

Blue prints consist of foundation plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

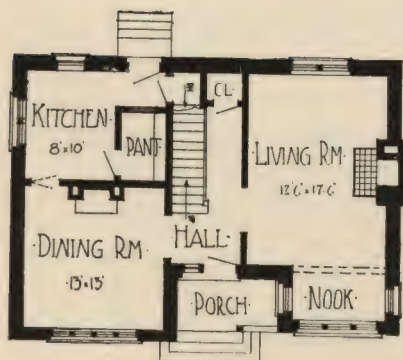
of Blue Prints, together with a complete set of typewritten specifications

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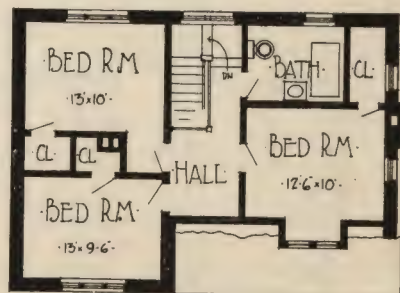
\$28.00

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ALTERATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.



First Floor Plan



Second Floor Plan



Design No. 9516

Size: Width, 45 feet; Length, 50 feet

Blue prints consist of basement plan; roof plan; first floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

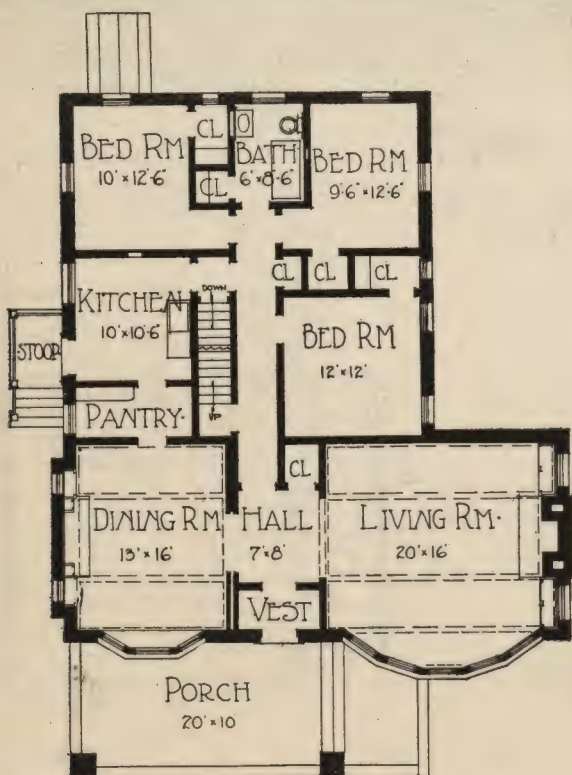
PRICE

of Blue Prints, together with a complete set of typewritten specifications

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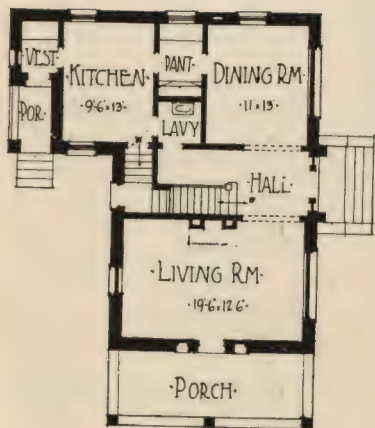
Floor Plan

EXCHANGING PLANS. If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.



Design No. 9547

Size: Width, 33 feet; Length, 36 feet 6 inches



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

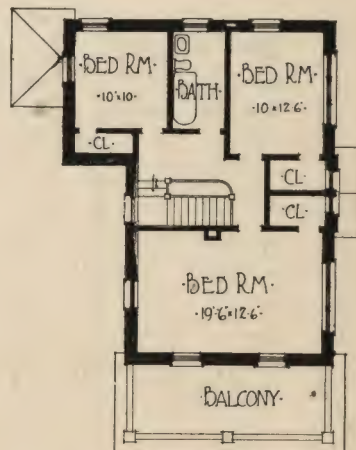
PRICE

of Blue Prints, together with a complete set of typewritten specifications.

ONLY

\$38.00

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Second Floor Plan

ALTERATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.



Design No. 9538

Size: Width, 28 feet 6 inches; Length, 39 feet

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

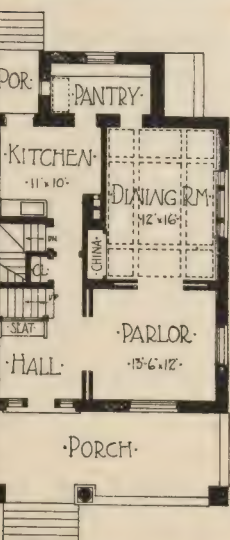
PRICE

of Blue Prints, together with a complete set of typewritten specifications

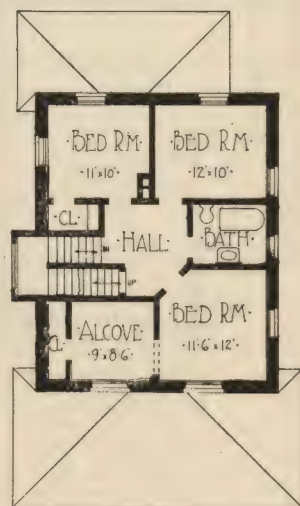
ONLY

\$36.00

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First Floor Plan



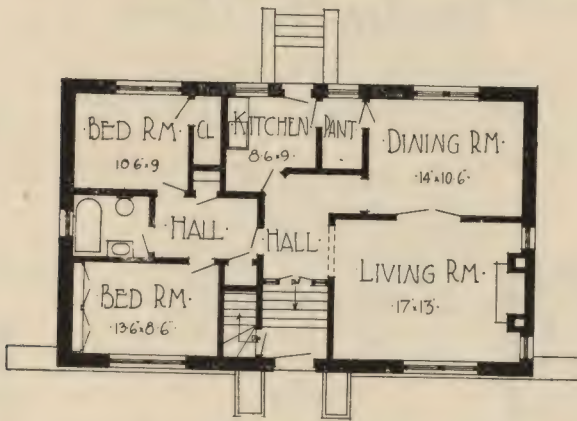
Second Floor Plan

ESTIMATED COST. A schedule of costs is given on page 219. See also preface page 130.



Design No. 9504

Size: Width, 44 feet 6 inches; Length, 27 feet



Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$16.00

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Design No. 9543

Size: Width, 40 feet; Length, 32 feet

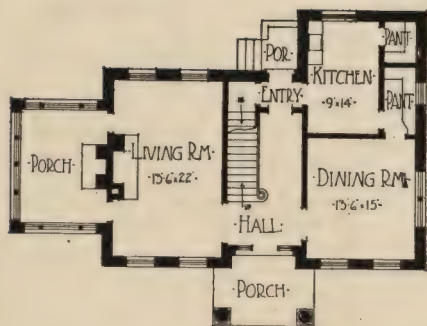
Blue prints consist of roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

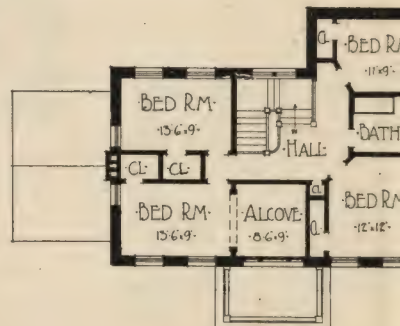
of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$36.00



First Floor Plan



Second Floor Plan

We mail Plans and Specifications the same day order is received.

ALTERATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.



Design No. 9550

Size: Width, 38 feet 9 inches; Length, 38 feet 6 inches

Blue prints consist of base-ment plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

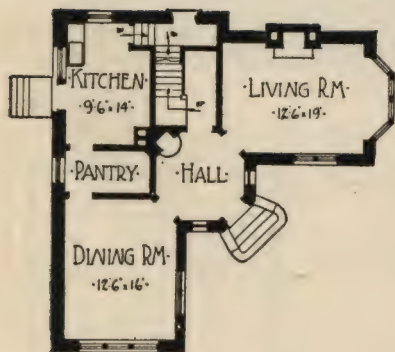
PRICE

of Blue Prints together with a complete set of typewritten specifications

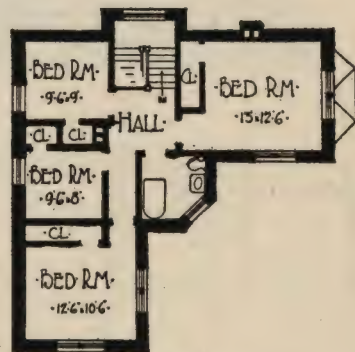
ONLY

\$36.00

We mail Plans and Specifications the same day order is received.



First Floor Plan



Second Floor Plan

EXCHANGING PLANS. If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.



Design No. 9544

Size: Width, 32 feet; Length, 42 feet 6 inches

Blue prints consist of foundation plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

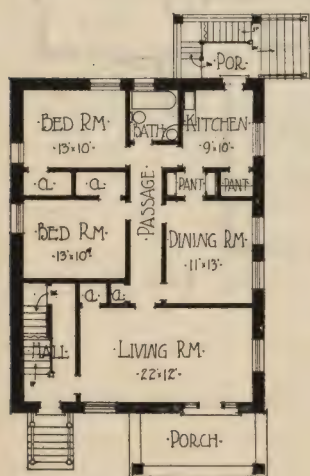
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$46.00

We mail Plans and Specifications the same day order is received.



First Floor Plan



Second Floor Plan



Design No. 9546

Size: Width, 37 feet; Length, 29 feet



First Floor Plan

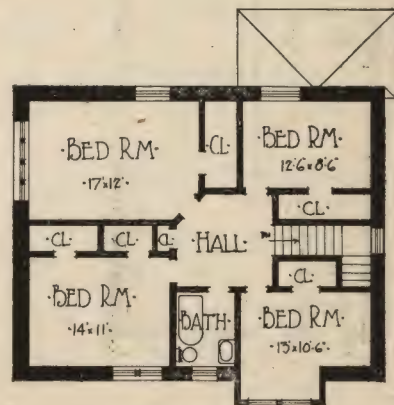
PRICE

of Blue Prints, together with
a complete set of typewritten
specifications

ONLY

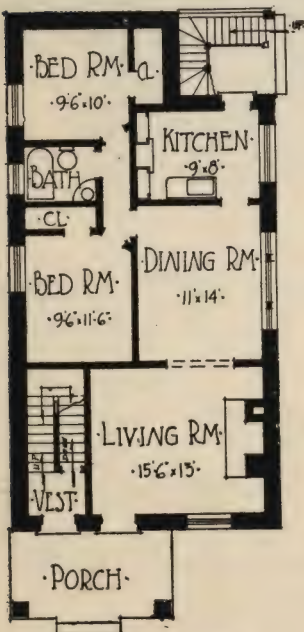
\$38.00

We mail Plans and Specifi-
cations the same day order is
received.

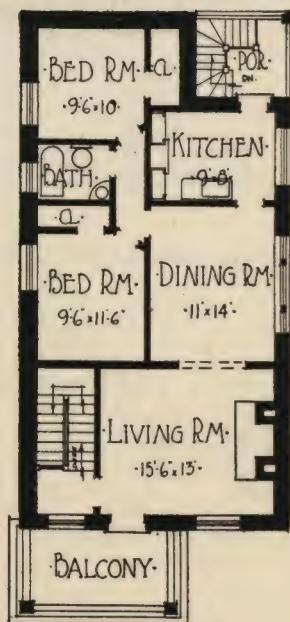


Second Floor Plan

Blue Prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.



First Floor Plan



Second Floor Plan

Design No. 9541

Size: Width, 24 feet; Length, 46 feet 4 inches

Blue prints consist of foundation plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$46.00

We mail Plans and Specifications the same day order is received.

EXCHANGING PLANS.

If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.



Design No. 9513

Size: Width, 31 feet; Length, 60 feet 6 inches

Blue prints consist of basement plan; roof plan; first floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

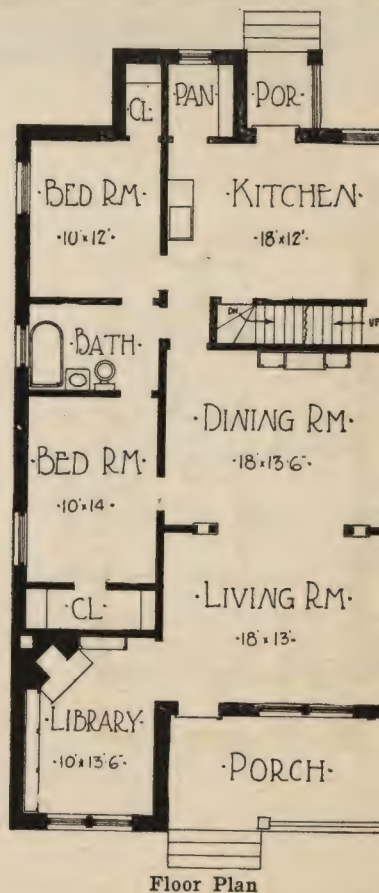
of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$20.00

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Design No. 9555

Size: Width, 40 feet; Length, 37 feet 6 inches



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

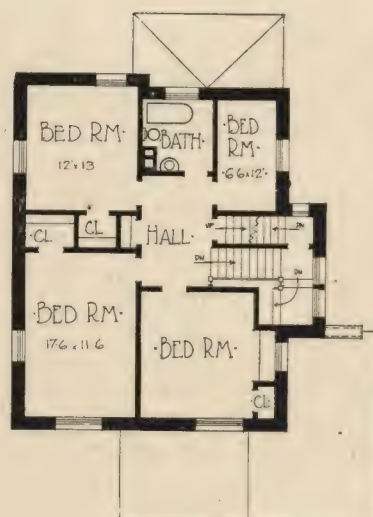
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$42.00

We mail Plans and Specifications the same day order is received.



Second Floor Plan

ALTERATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.



Design No. 9556

Size: Width, 41 feet 6 inches; Length, 33 feet 6 inches

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

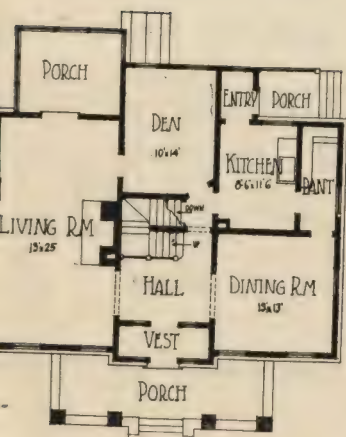
PRICE

of Blue Prints, together with a complete set of typewritten specifications.

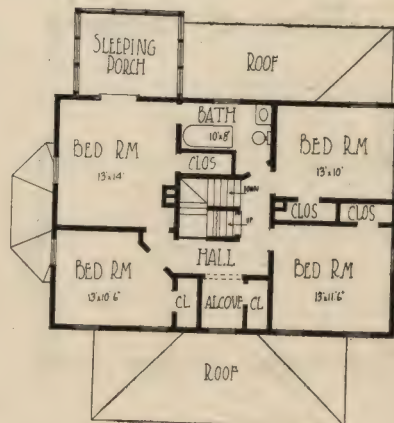
ONLY

\$42.00

We mail Plans and Specifications the same day order is received.



First Floor Plan



Second Floor Plan

ESTIMATED COST. A schedule of costs is given on page 219. See also preface page 130.



Design No. 9552

Size: Width, 35 feet; Length,
46 feet 6 inches

Blue prints consist of base-
ment plan; first and second
floor plans; front, two side
elevations; wall sections and
all necessary interior details.
Specifications consist of twenty-
two pages of typewritten
matter.

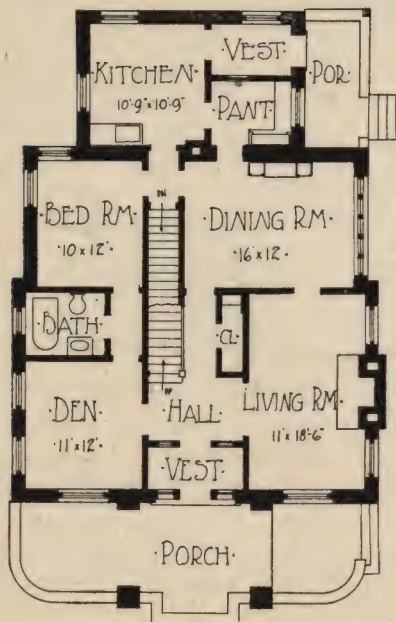
PRICE

of Blue Prints, together with
a complete set of typewritten
specifications

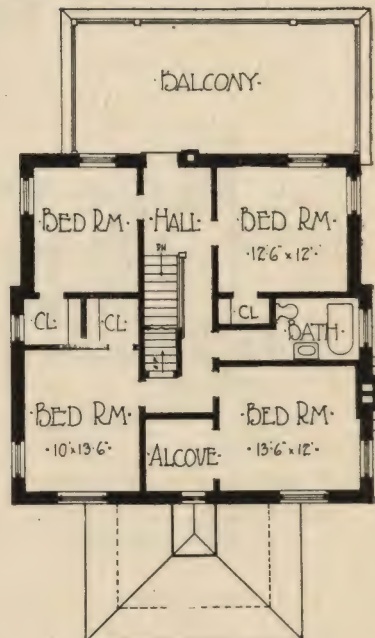
ONLY

\$44.00

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fications the same day order is
received.



First Floor Plan



Second Floor Plan

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Design No. 9530

Size: Width, 32 feet; Length, 32 feet

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

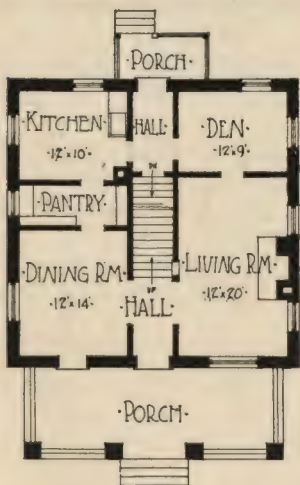
PRICE

of Blue Prints, together with a complete set of typewritten specifications

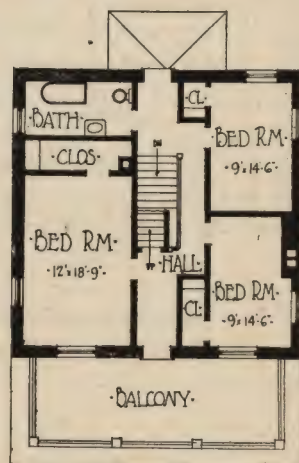
ONLY

\$30.00

We mail Plans and Specifications the same day order is received.



First Floor Plan



Second Floor Plan

EXCHANGING PLANS.

If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.



Design No. 9558

Size: Width, 36 feet 6 inches; Length, 50 feet



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

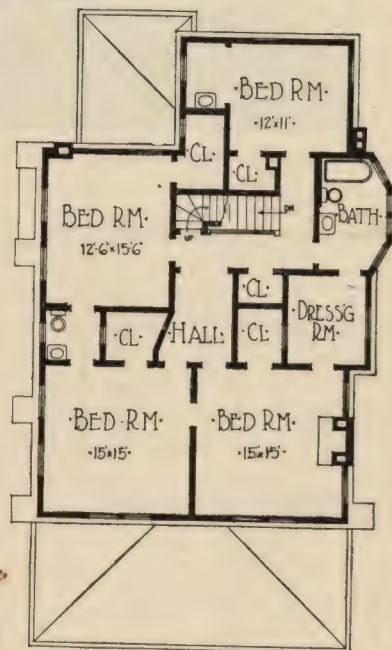
PRICE

of Blue Prints, together with a complete set of typewritten specifications.

ONLY

\$44.00

We mail Plans and Specifications the same day order is received.



Second Floor Plan

ESTIMATED COST. A schedule of costs is given on page 219. See also preface page 130.



Design No. 9520

Size: Width, 32 feet 6 inches;
Length, 42 feet

Blue prints consist of basement plan; attic and roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

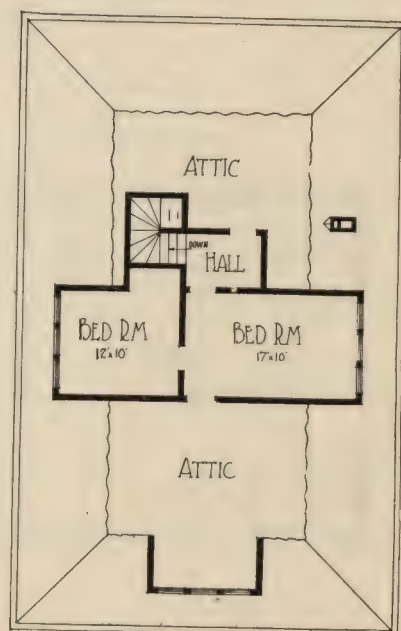
ONLY

\$22.00

We mail Plans and Specifications the same day order is received.



First Floor Plan



Second Floor Plan

NOTES. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.



Design No. 9522

Size: Width, 25 feet 6 inches; Length, 25 feet 6 inches



First Floor Plan

Blue prints consist of base-ment plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of type-written matter.

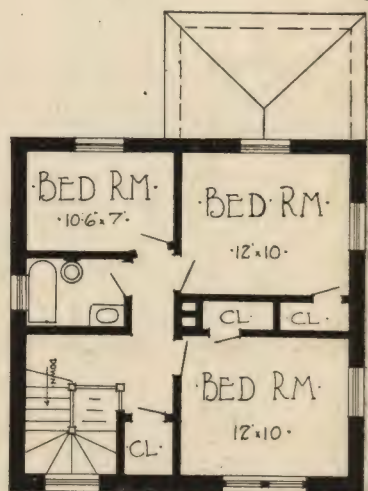
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$28.00

We mail Plans and Specifications the same day order is received.



Second Floor Plan

EXCHANGING PLANS. If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.



Design No. 9537

Size: Width, 38 feet; Length, 36 feet

Blue prints consist of cellar and foundation plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

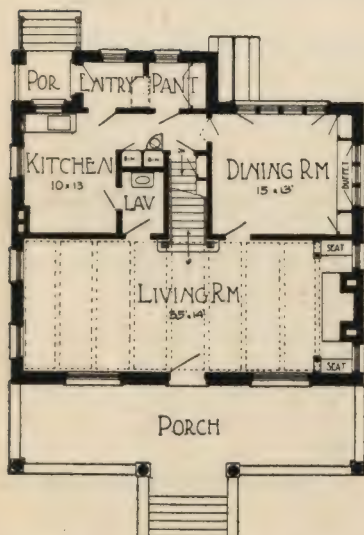
PRICE

of Blue Prints, together with a complete set of typewritten specifications

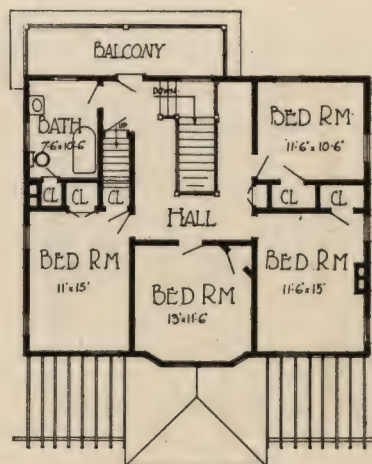
ONLY

\$34.00

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First Floor Plan



Second Floor Plan

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Design No. 9517

Size: Width, 26 feet 4 inches; Length, 23 feet

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

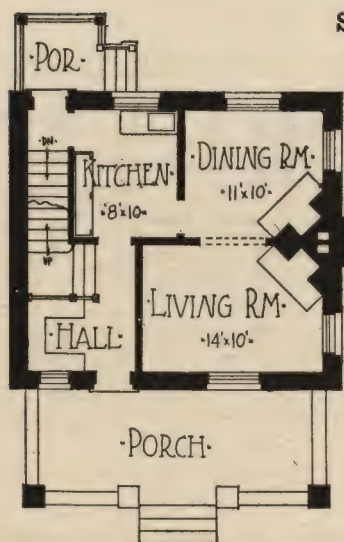
PRICE

of Blue Prints, together with a complete set of typewritten specifications

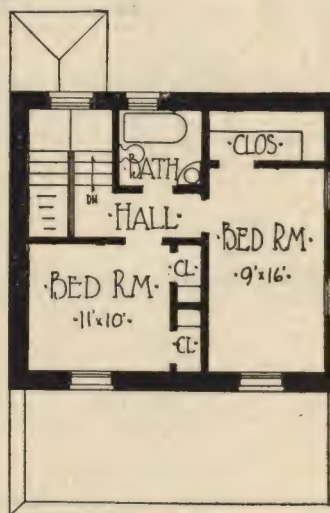
ONLY

\$26.00

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First Floor Plan



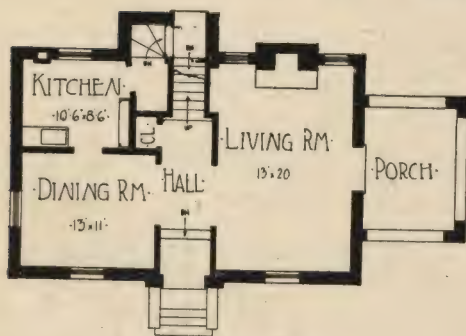
Second Floor Plan

ESTIMATED COST. A schedule of costs is given on page 219. See also preface page 130.



Design No. 9525

Size: Width, 34 feet; Length, 28 feet 8 inches



First Floor Plan

Blue prints consist of foundation plan; first and second floor plans; front, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.



Second Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$28.00

We mail Plans and Specifications the same day order is received.

ALTERATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.



Design No. 9514

Size: Width, 40 feet 3 inches; Length, (including garage) 57 feet, exclusive of porch



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of about twenty-two pages of typewritten matter.

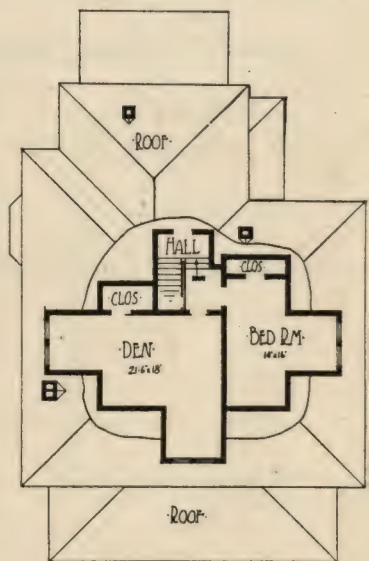
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$22.00

We mail Plans and Specifications the same day order is received.



Second Floor Plan

ALTERATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.



Design No. 9540

Size: Width, 42 feet; Length, 28 feet 6 inches

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

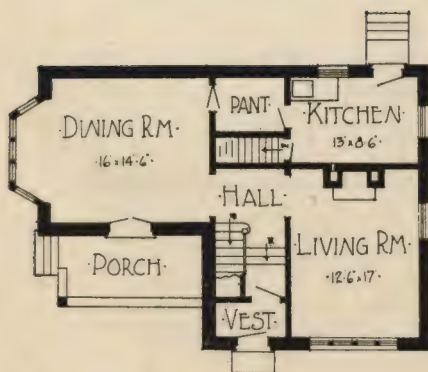
PRICE

of Blue Prints, together with a complete set of typewritten specifications

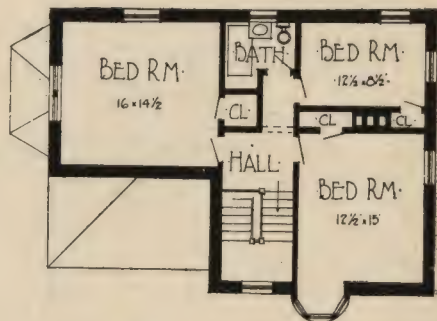
ONLY

\$32.00

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First Floor Plan



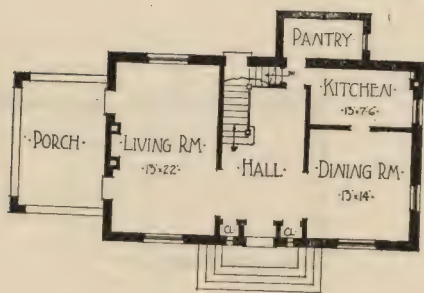
Second Floor Plan

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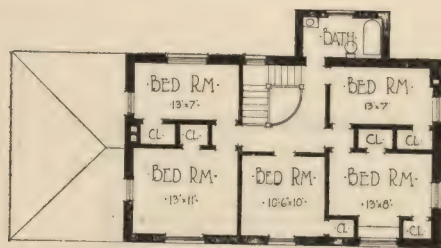
Design No. 9539

Size: Width, 40 feet 3 inches; Length, 30 feet



First Floor Plan

Blue prints consist of basement plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.



Second Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$36.00

We mail Plans and Specifications the same day order is received.

ESTIMATED COST. A schedule of costs is given on page 219. See also preface page 130.



Design No. 9507

Size: Width, 29 feet; Length, 49 feet 6 inches

Blue prints consist of basement plan; roof plan; floor plan; front, rear and two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

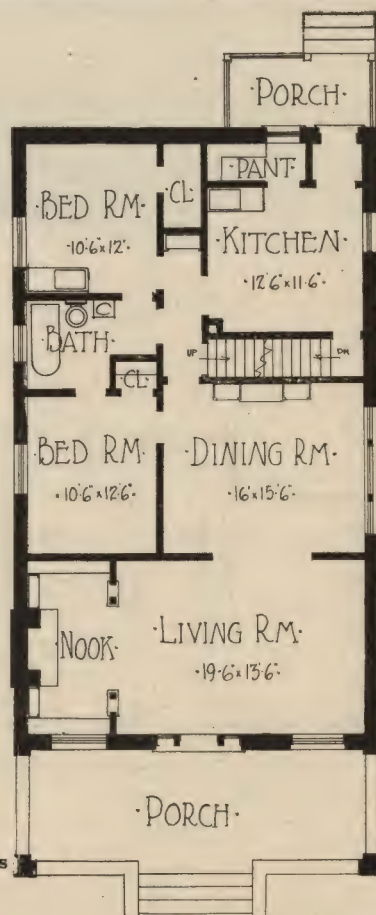
of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$18.00

We mail Plans and Specifications the same day order is received.

EXCHANGING PLANS. If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.

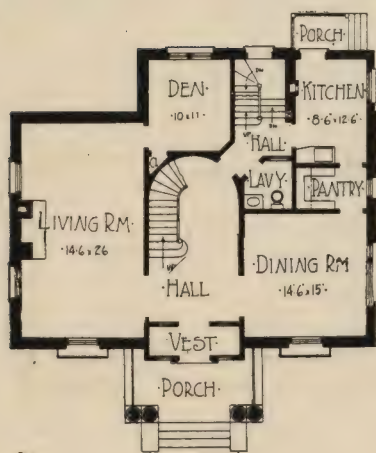


Floor Plan



Design No. 9553

Size: Width, 44 feet; Length, 37 feet 6 inches



First Floor Plan

Blue prints consist of foundation plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$40.00

We mail Plans and Specifications the same day order is received.



Second Floor Plan

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Design No. 9502

Size: Width, 28 feet 6 inches; Length,
37 feet 6 inches

Blue prints consist of basement plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

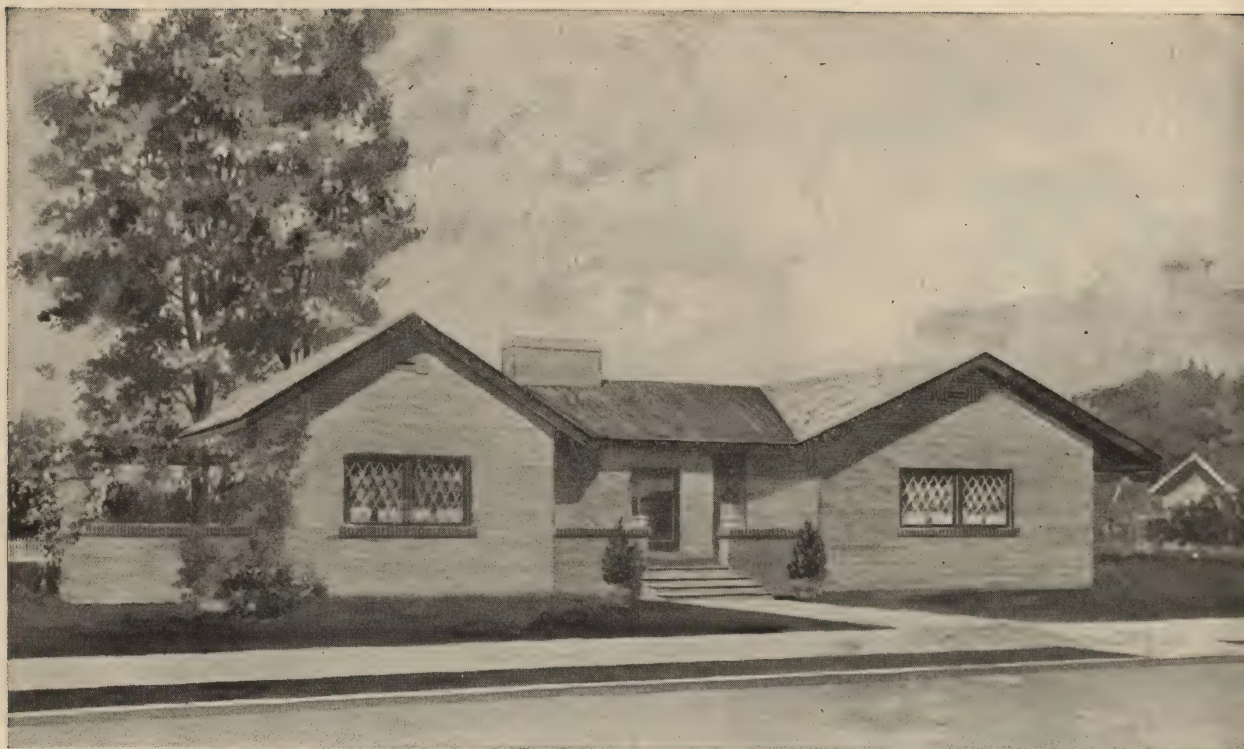
\$16.00

We mail Plans and Specifications the same day order is received.

ALTERATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.



Floor Plan



Design No. 9509

Size: Width, 52 feet 6 inches; Length, 28 feet



Floor Plan

Blue prints consist of base-ment plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$18.00

We mail Plans and Specifications the same day order is received.

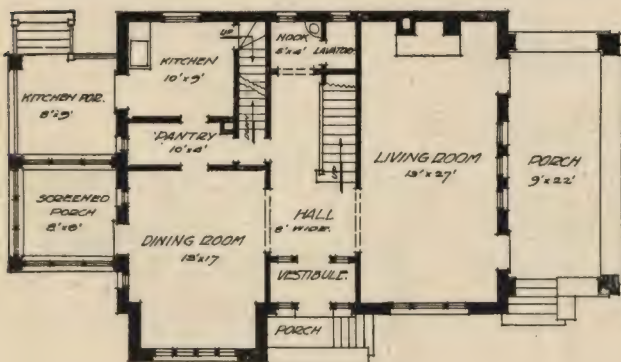
EXCHANGING PLANS. If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.



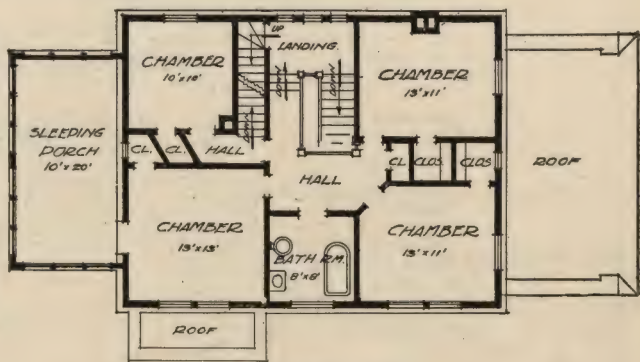
Design No. 9536

Size: Width, 37 feet; Length, 33 feet 6 inches, exclusive of porches

Blue Prints consist of cellar and foundation plan; roof plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary details. Specifications consist of about twenty-two pages of typewritten matter.



First Floor Plan



Second Floor Plan

PRICE

of Blue Prints, together with a complete set of typewritten specifications

\$34.00

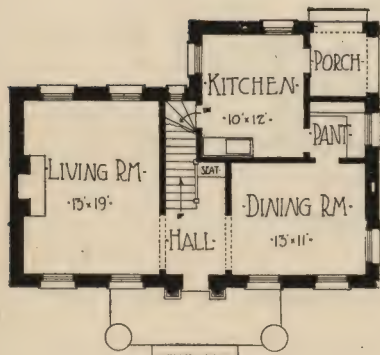
We mail plans and specifications the same day order is received.

ESTIMATED COST. A schedule of costs is given on page 219. See also preface page 130.



Design No. 9545

Size: Width, 36 feet; Length, 26 feet



First Floor Plan

Blue prints consist of basement plan; first and second floor plans; front, rear, and two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

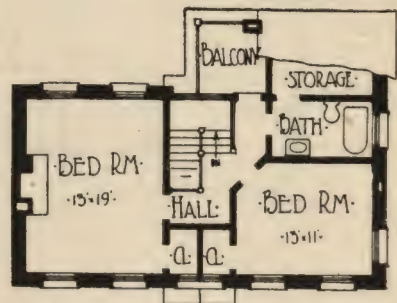
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$38.00

We mail Plans and Specifications the same day order is received.



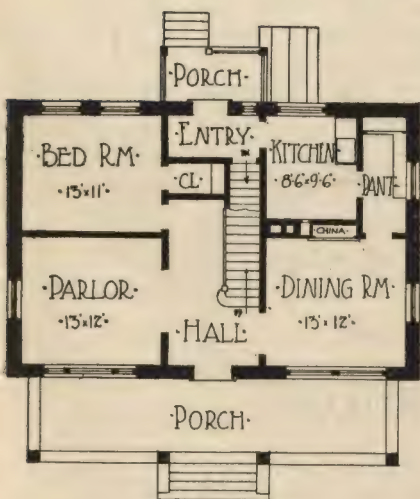
Second Floor Plan

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Design No. 9531

Size: Width, 38 feet; Length, 26 feet



First Floor Plan

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

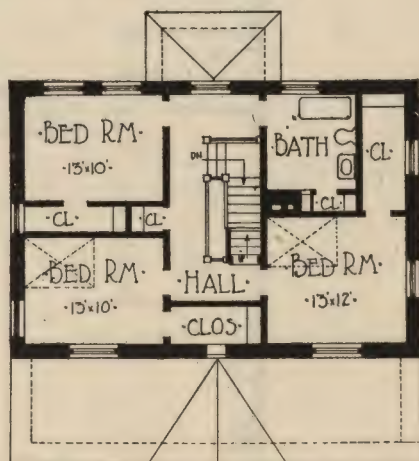
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$30.00

We mail Plans and Specifications the same day order is received.



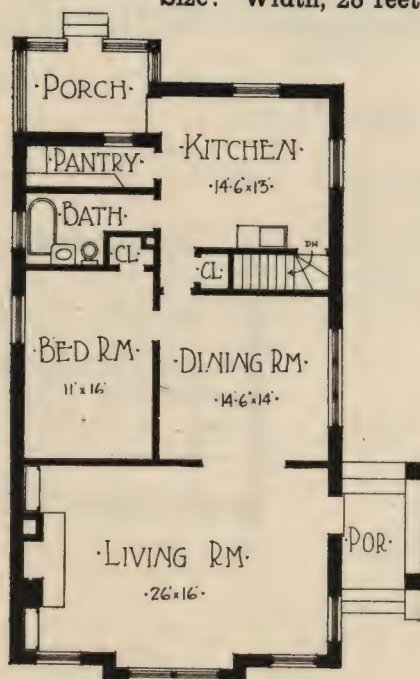
Second Floor Plan

EXCHANGING PLANS. If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.



Design No. 9511

Size: Width, 28 feet 6 inches; Length, 51 feet



Floor Plan

Blue prints consist of foundation plan; roof plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$18.00

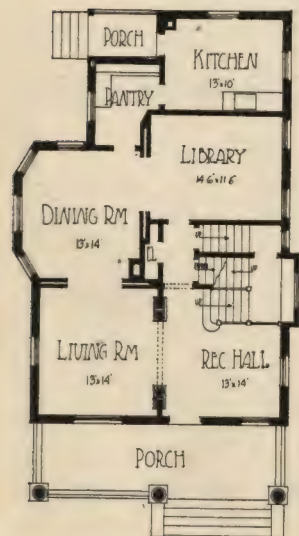
We mail Plans and Specifications the same day order is received.

ALTERATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.

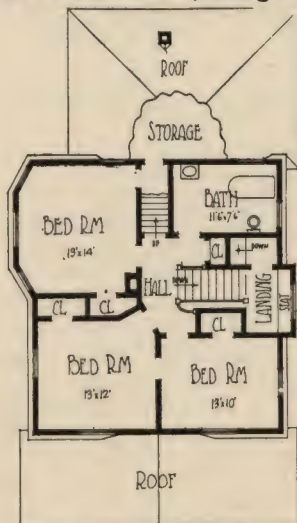


Design No. 9551

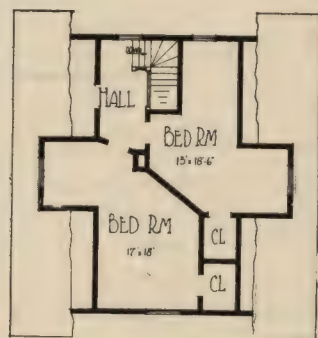
Size: Width, 31 feet 6 inches; Length, 45 feet 6 inches



First Floor Plan



Second Floor Plan



Third Floor Plan

Blue prints consist of basement plan; roof plan; first and second and third floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE
of Blue Prints, together with a complete set of typewritten specifications

ONLY
\$42.00

We mail Plans and Specifications the same day order is received.



Design No. 9506

Size: Width, 29 feet; Length, 48 feet 6 inches

Blue prints consist of basement plan; floor plan; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$16.00

We mail Plans and Specifications the same day order is received.

EXCHANGING PLANS. If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.



Design No. 9523

Size: Width, 30 feet 6 inches; Length, 26 feet



First Floor Plan

Blue prints consist of basement plan; first and second floor plans; front, rear, two side elevations; wall sections and all necessary interior details. Specifications consist of twenty-two pages of typewritten matter.

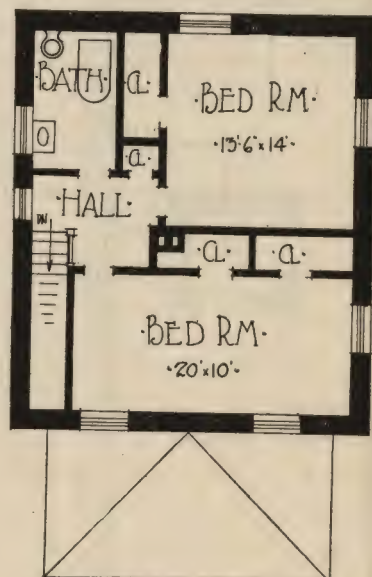
PRICE

of Blue Prints, together with a complete set of typewritten specifications

ONLY

\$28.00

We mail Plans and Specifications the same day order is received.



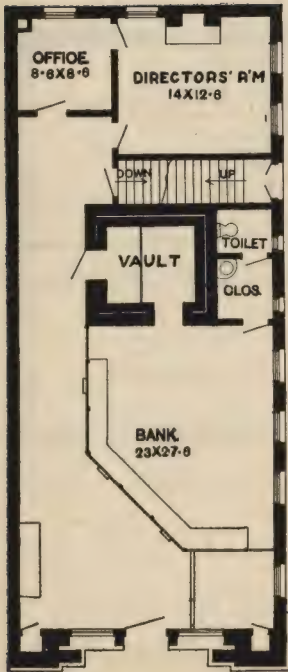
Second Floor Plan

PLANS FROM YOUR OWN SKETCHES. Our skilled architects will prepare at lowest cost finished plans embodying your ideas. Write us for full particulars.



DESIGN NO. 4018.

Size: Width, 25 feet; Length, 60 feet.



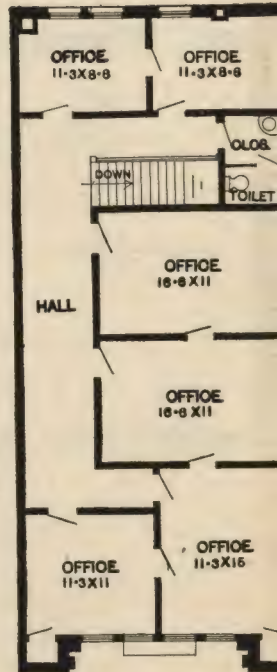
First Floor Plan

Blue Prints consist of basement plan; first and second floor plans; all necessary elevations and necessary interior and exterior details.

Specifications are typewritten and contain all the information necessary for the proper construction of the building.

Price of Plans and Specifications.....\$15.00

Very attractive design for Bank Building to be constructed of brick with front of stone and brick making a very handsome and practical building suitable for any city or town. The first floor is devoted exclusively to banking purposes. In the center is placed a large fire-proof vault. Back of the vault the entrance and stairs to the basement are located. In the extreme rear provision is made for a directors' room, 14 feet by 12 feet 6 inches, and a small private office 8 feet 6 inches square with entrance to both the directors' room and the bank proper. The second floor is devoted entirely to offices, and if not required for use by bank can be rented separately or en suite. Estimated cost of construction under favorable conditions from about \$5100.00 to about \$5800.00.



Second Floor Plan



DESIGN NO. 4089.

Size: Width, 25 feet; Length, 60 feet.

Blue Prints consist of basement plan; first and second floor plans; all necessary elevations and necessary interior details. Specifications are typewritten and contain all the information necessary for the proper construction of the building.

Price of Plans and Specifications.....\$10.00

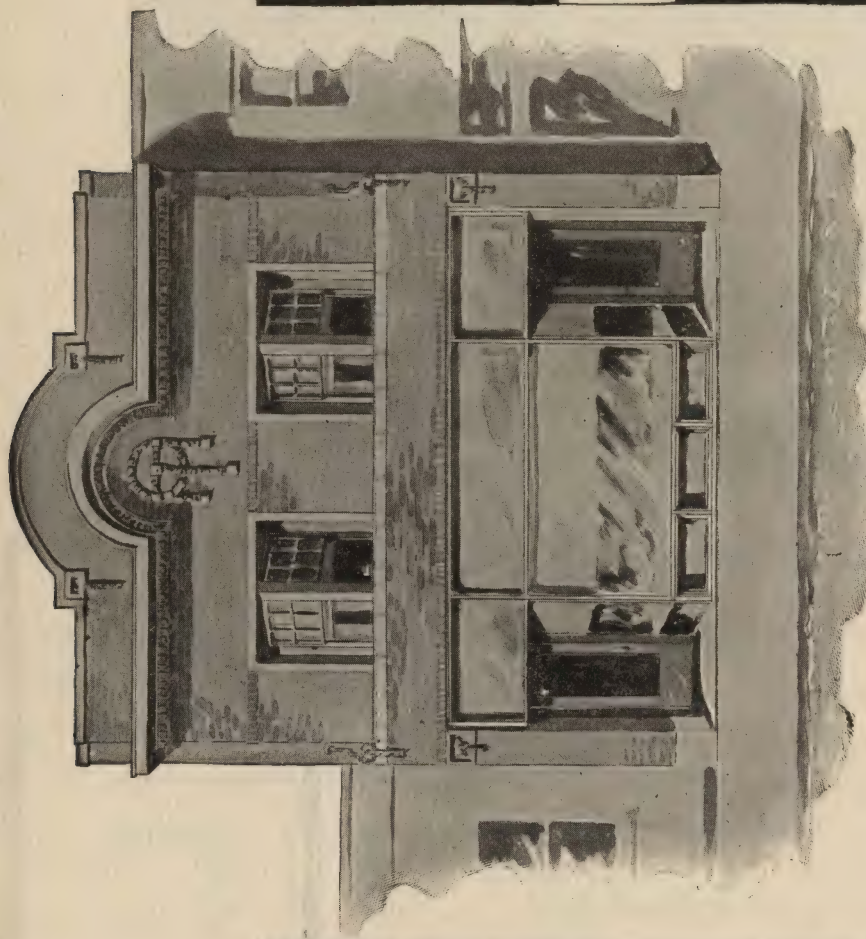
Popular style for two-story building of brick with stone trimmings designed for a lodge hall with store underneath, the entire first floor being devoted to that purpose. The lodge room proper on the upper floor is 22 feet 6 inches by 42 feet with ante-room 16 feet 6 inches by 14 feet 6 inches, closet and hall with stairway leading to street. Estimated cost of construction under favorable conditions, from about \$5000.00 to about \$5500.00.



First Floor Plan



Second Floor Plan



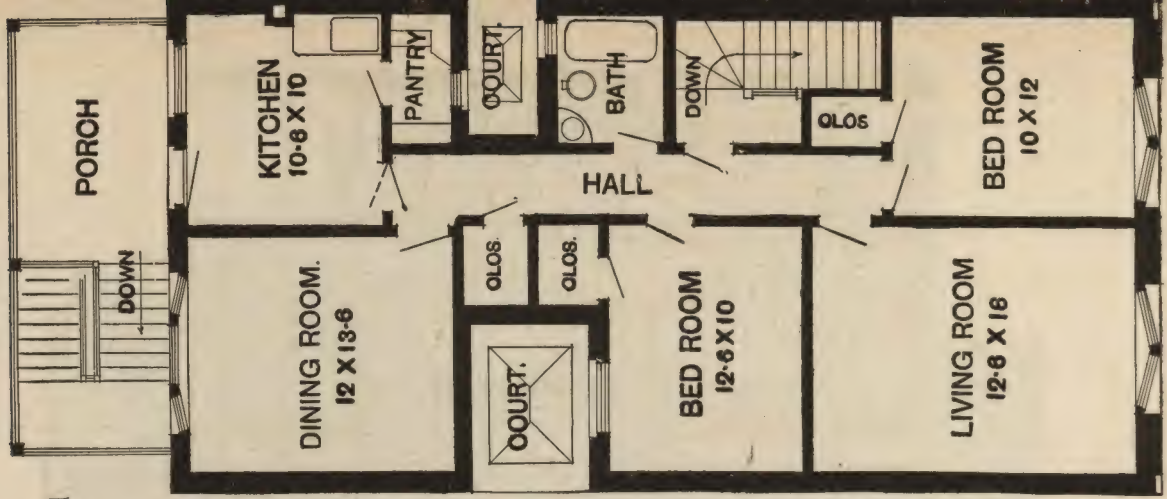
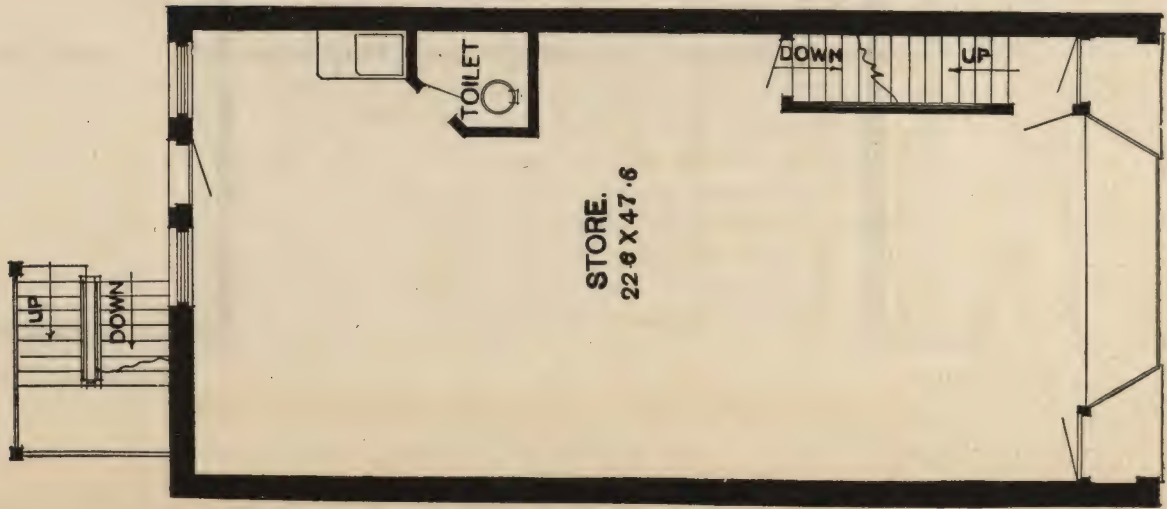
DESIGN NO. 4009.

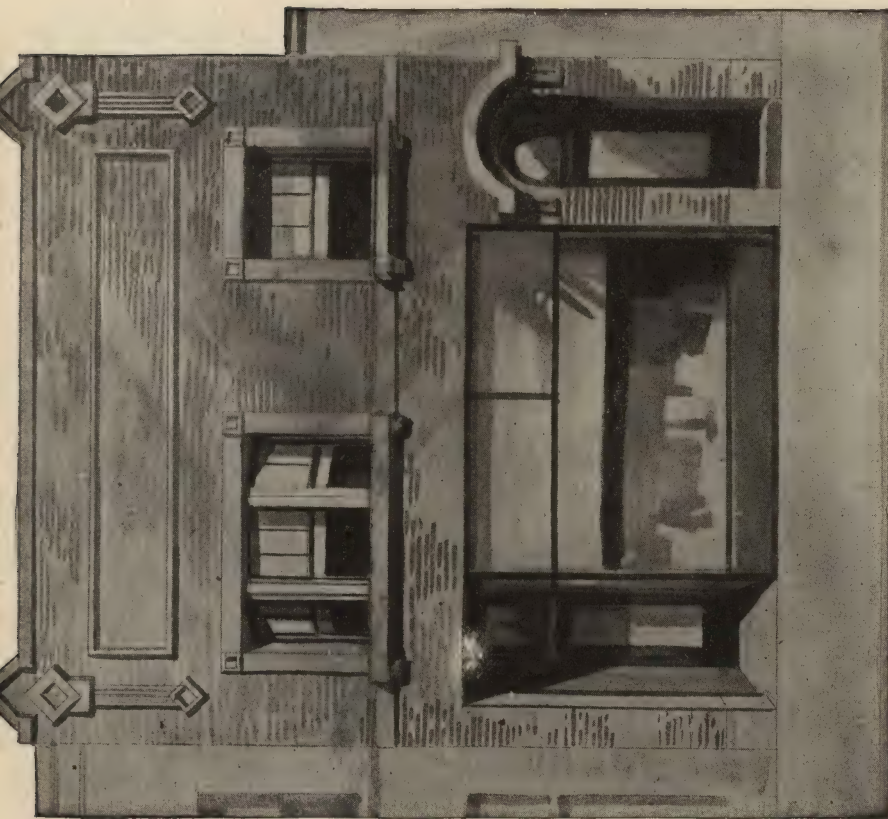
Size: Width, 25 feet; Length, 50 feet.

Blue Prints consist of basement plan; first and second floor plan; all necessary elevations and interior details. Specifications are type-written and contain all the information necessary for the proper construction of the building.

Price of Plans and Specifications.....\$15.00

Original and attractive design for Store and Flat Building to be constructed of brick with stone trimmings. The entire lower floor is devoted to store room purposes with one large show window in center. Entrance to the store is located at one side and to second floor on opposite side. There is also an entrance from the store to the hall going upstairs. Basement is full height and has entrance from the store. The second floor consists of living room, dining room, kitchen, two bedrooms, bath, pantry, closets, etc. Large back porch. Estimated cost of construction, under favorable conditions, from about \$4100.00 to \$4500.00.





DESIGN NO. 4003

Size: Width, 25 feet; Length, 50 feet.

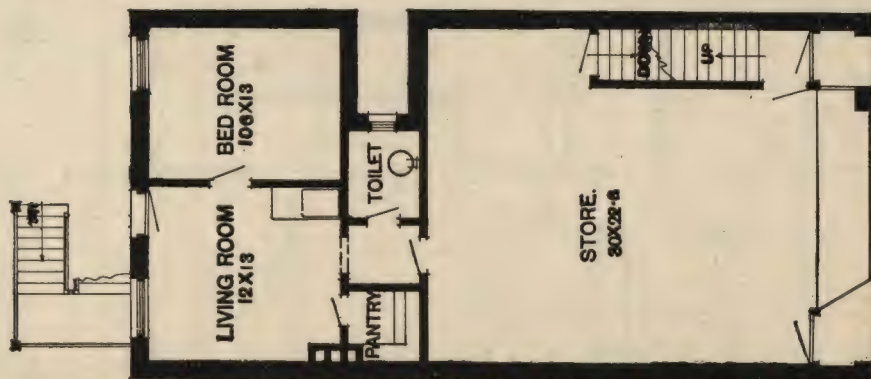
Blue Prints consist of basement plan; first and second floor plans; all necessary elevations and necessary interior details.

Specifications are typewritten and contain all the information necessary for the proper construction of the building.

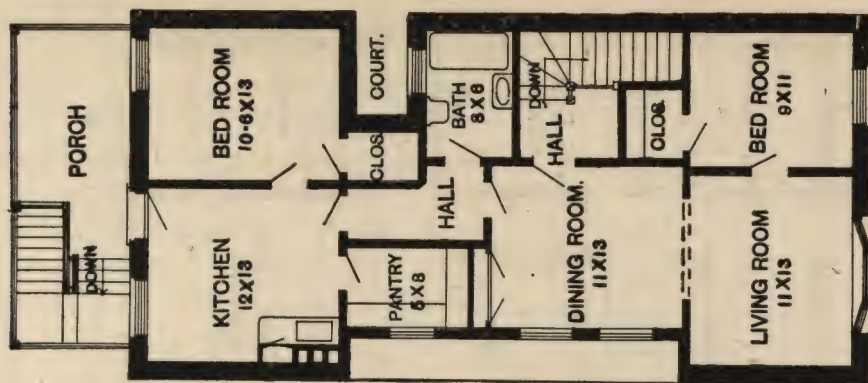
Price of Plans and Specifications.....\$15.00

Very neat and practical design for Store and Flat Building of brick with stone trimmings. First floor is divided into a store 30 feet by 22 feet 6 inches with living room, bedroom, pantry and lavatory in rear, while the second floor contains living room, dining room, kitchen, two chambers, bath, pantry, halls and closets. This style of building is designed especially for a city lot, but is also well suited to small towns, suburbs or villages and is the kind of a building that will never be a drug on the market should it be necessary to dispose of it.

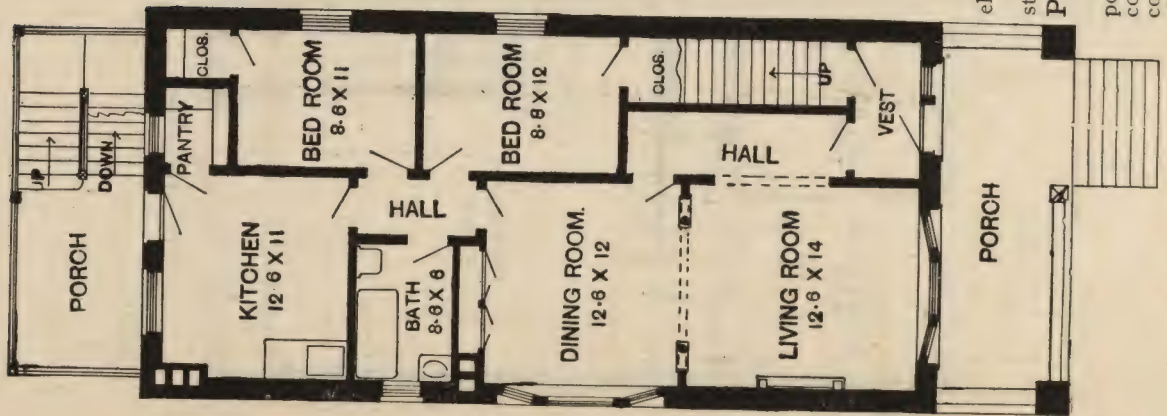
Estimated cost of construction under favorable conditions from about \$4,300.00 to about \$5,000.00.



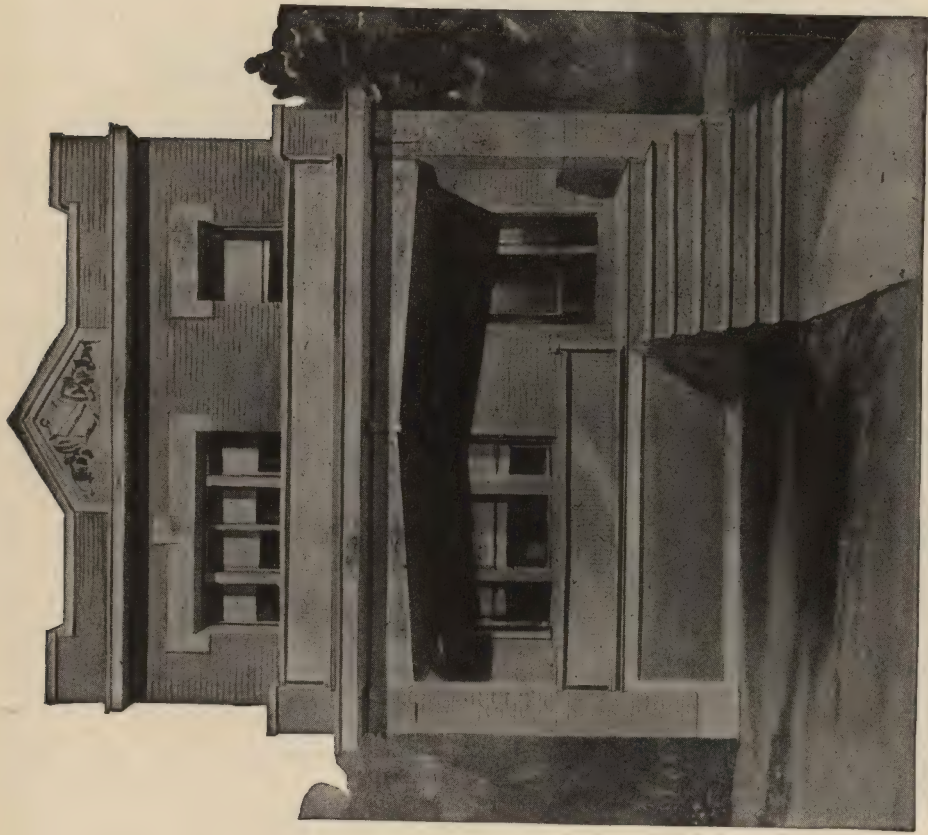
First Floor Plan



Second Floor Plan



First Floor Plan

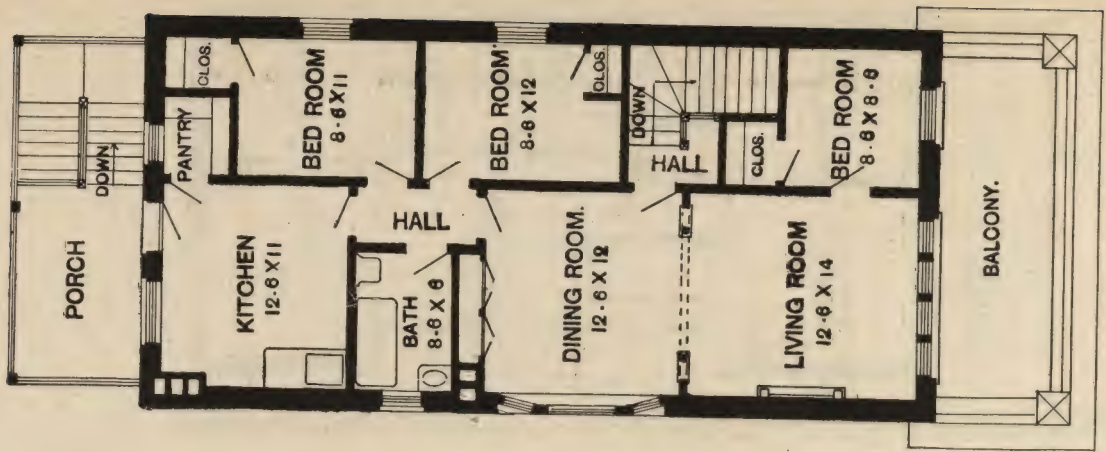


DESIGN NO. 4044.

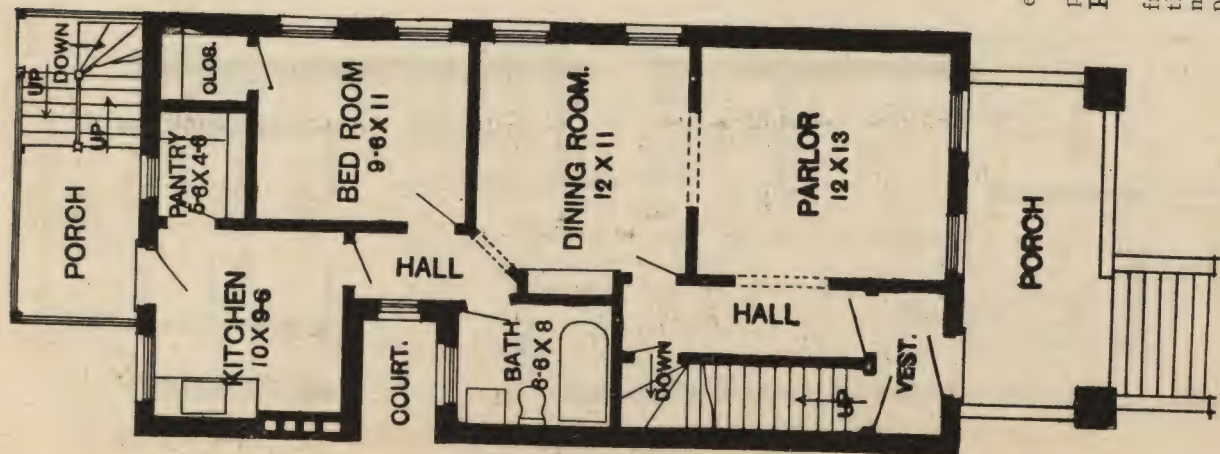
Size: Width, 24 feet; Length, 48 feet 6 inches.

Blue Prints consist of basement plan; first and second floor plans; all necessary elevations and interior details.
Specifications are typewritten and contain all the information for the proper construction of the building.

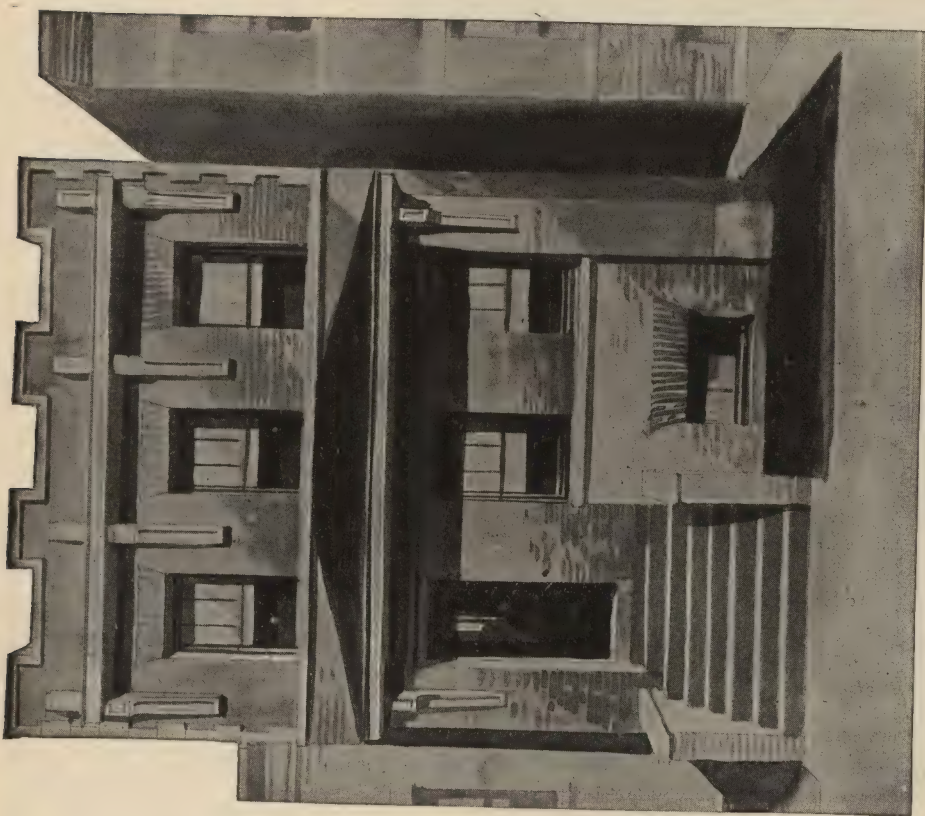
Price of Plans and Specifications \$15.00
Two Flat Building of brick construction with stone trimmings. Large wooden porch, extends clear across the front with balcony for the second floor. First floor contains five large rooms, bath, pantry, halls, closets, etc., while the second floor contains six rooms, bath, halls, closets, etc. Large back porches. This particular style of architecture is very popular at the present time, and a house built after this design will look well in any community.
Estimated cost of construction under favorable conditions from about \$3,900.00 to about \$4,500.00.



Second Floor Plan



First Floor Plan



DESIGN NO. 4021.

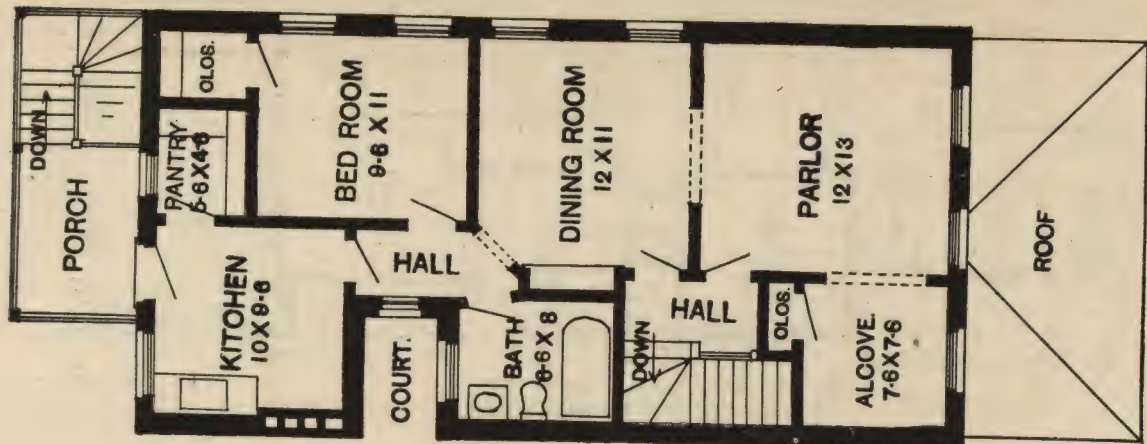
Size: Width, 22 feet; Length, 43 feet.

Blue Prints consist of basement plan; first and second floor plans; all necessary elevations and necessary interior details.

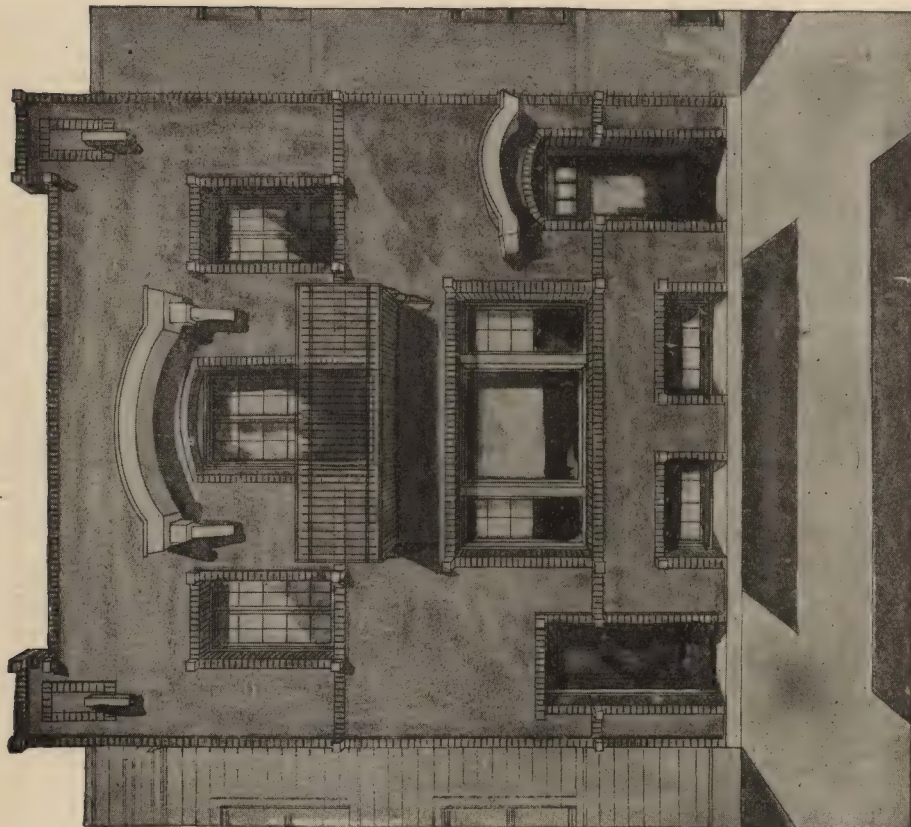
Specifications are typewritten and contain all the information necessary for the proper construction of the building.

Price of Plans and Specifications.....\$15.00

Colonial Design for two flat building of brick with stone trimmings. Large front porch for use of both families. This building was designed especially for the City, the width being 22 feet and it meets with all the City Building requirements. The first floor consists of parlor, dining room, kitchen, bedroom, bath, pantry, closets, etc. The second floor is practically the same but has the addition of an alcove opening from the parlor. The estimated cost of construction for a building of this kind, under favorable conditions, is from about \$4000.00 to about \$4500.00.



Second Floor Plan



DESIGN NO. 4001.

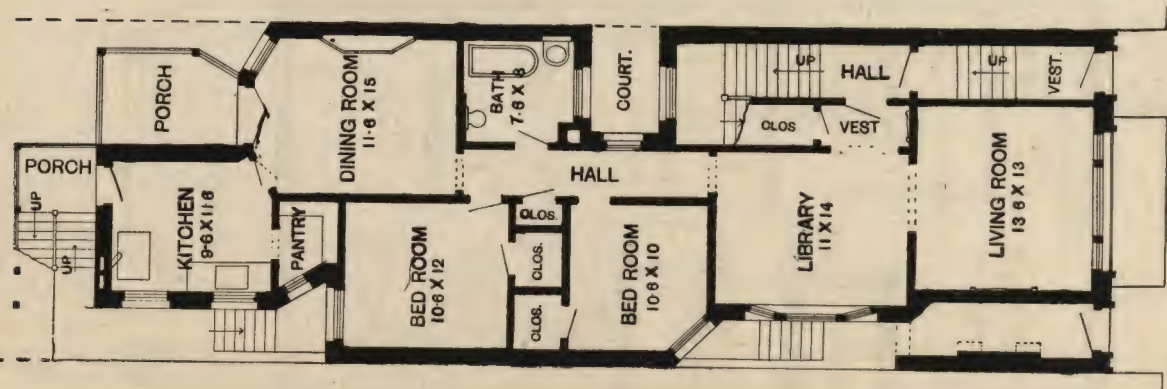
Size: Width, 25 feet; Length, 73 feet 6 inches.

Blue Prints consist of basement plan; first and second floor plans; all elevations and necessary interior details.

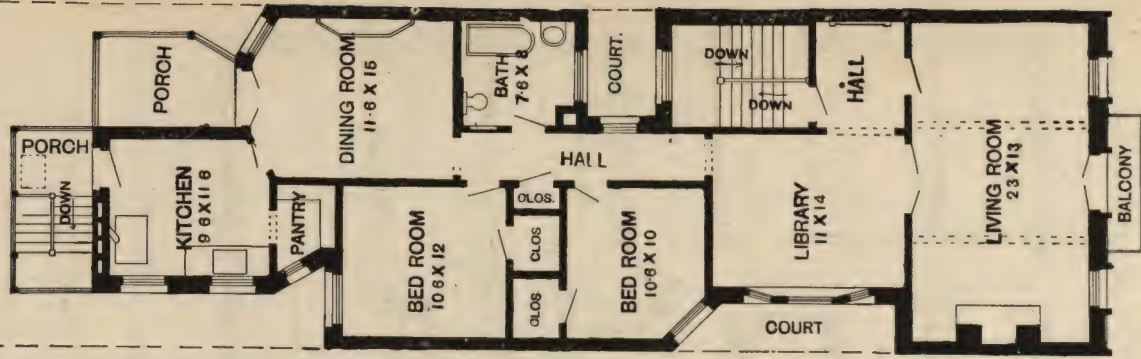
Specifications are typewritten and contain all the information necessary for the proper construction of the building.

Price of Plans and Specifications.....\$15.00

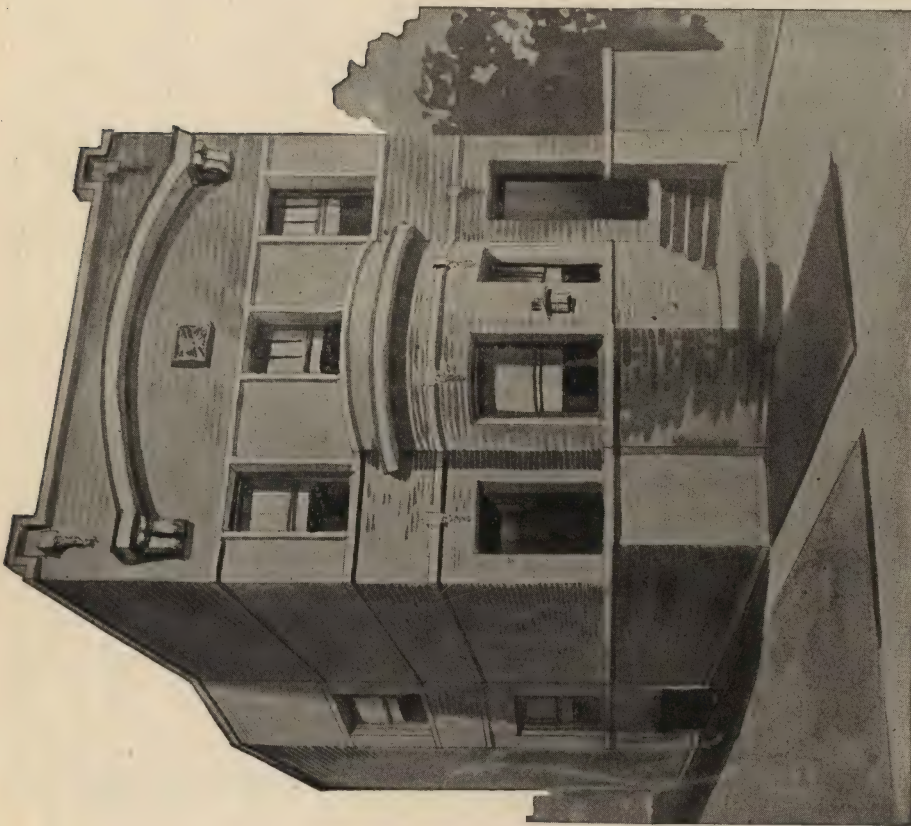
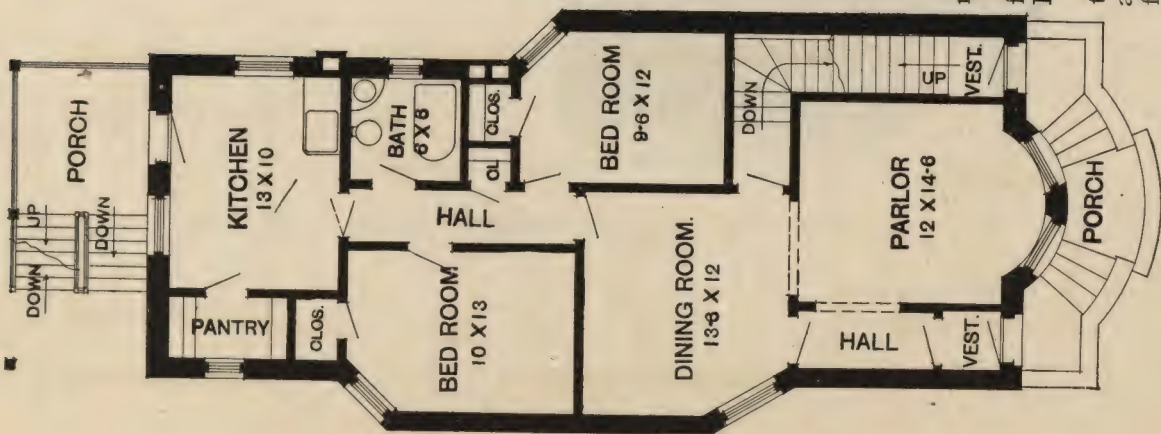
Two Family Brick House with front of Cream Plaster and red brick trimmings. Large French windows on second floor opening onto a wrought iron balcony. This building was designed for an ordinary city lot where economy of space is essential. The private porches opening from dining rooms are a feature. Estimated cost of construction under favorable conditions from about \$6000.00 to \$7000.00.



First Floor Plan



Second Floor Plan



DESIGN NO. 4006.

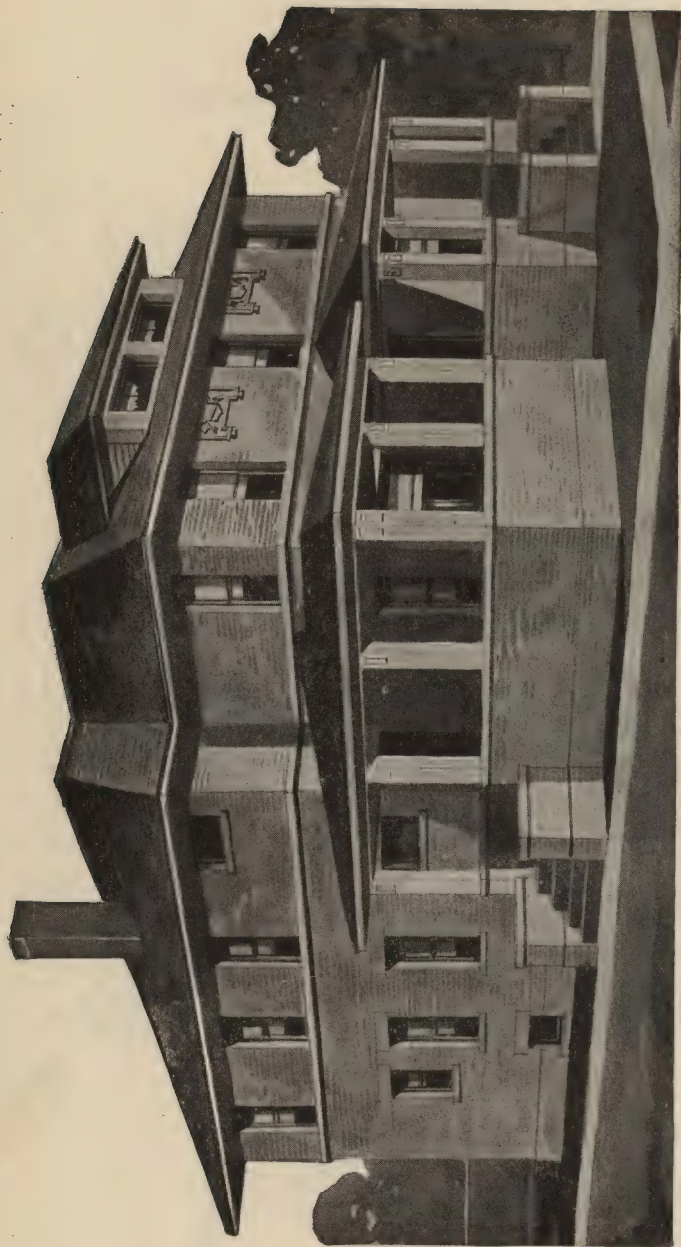
Size: Width, 25 feet; Length, 54 feet.

Blue Prints consist of basement plan; first and second floor plans; all necessary elevations and necessary interior details.

Specifications are typewritten and contain all the information necessary for the proper construction of the building.

Price of Plans and Specifications.....\$15.00

Unique design for Two Flat Building constructed of brick with stone trimmings and plaster panels. Each apartment has a separate entrance affording privacy and complete isolation if desired. Each apartment has five good sized rooms, the upper floor gaining the additional space over entrance which can be devoted to a cosy corner or book room. Estimated cost of construction under favorable conditions from about \$4500.00 to about



DESIGN NO. 4026.

Size: Width, 40 feet 6 inches; Length, 55 feet.

See Opposite Page for First and Second Floor Plans for this building.

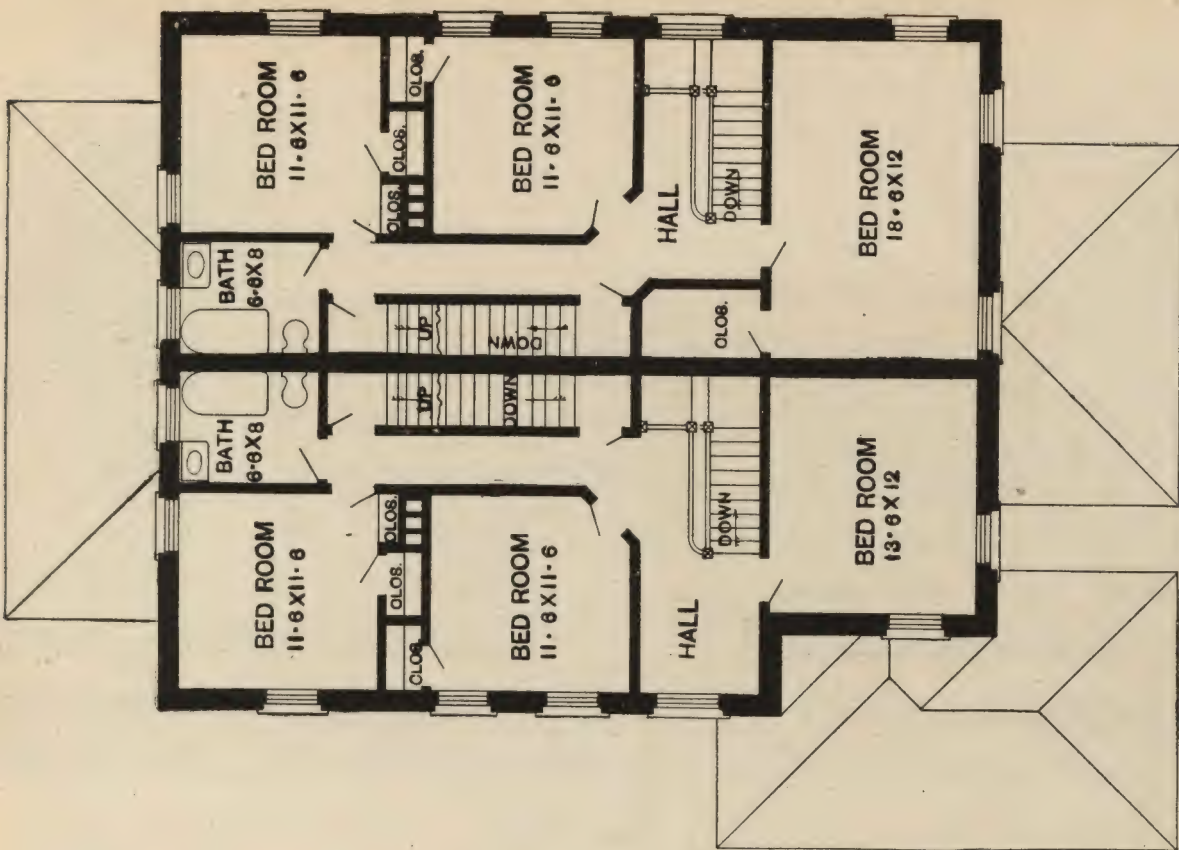
Blue Prints consist of basement plan; first and second floor plans; all necessary elevations and necessary interior details. Specifications are typewritten and contain all the information necessary for the proper construction of the building.

Price of Plans and Specifications..... \$20.00

Modern and commodious twin or double house of brick construction with stone trimmings, shingled roof. This design is large and well suited to a broad suburban lot. The entrance porches are well apart and the division is on a straight party line. The design is one of much dignity and the building will form a notable landmark in any locality. The first floor contains the reception hall, living room, dining room and kitchen and the second floor three large sleeping rooms, bath, hall, closets, etc. Estimated cost of construction, under favorable conditions, from about \$6700.00 to about \$7500.00.



First Floor Plan



Second Floor Plan

DESIGN NO. 4026.

See opposite page for Perspective View, description and price of plans and Specifications for this building.



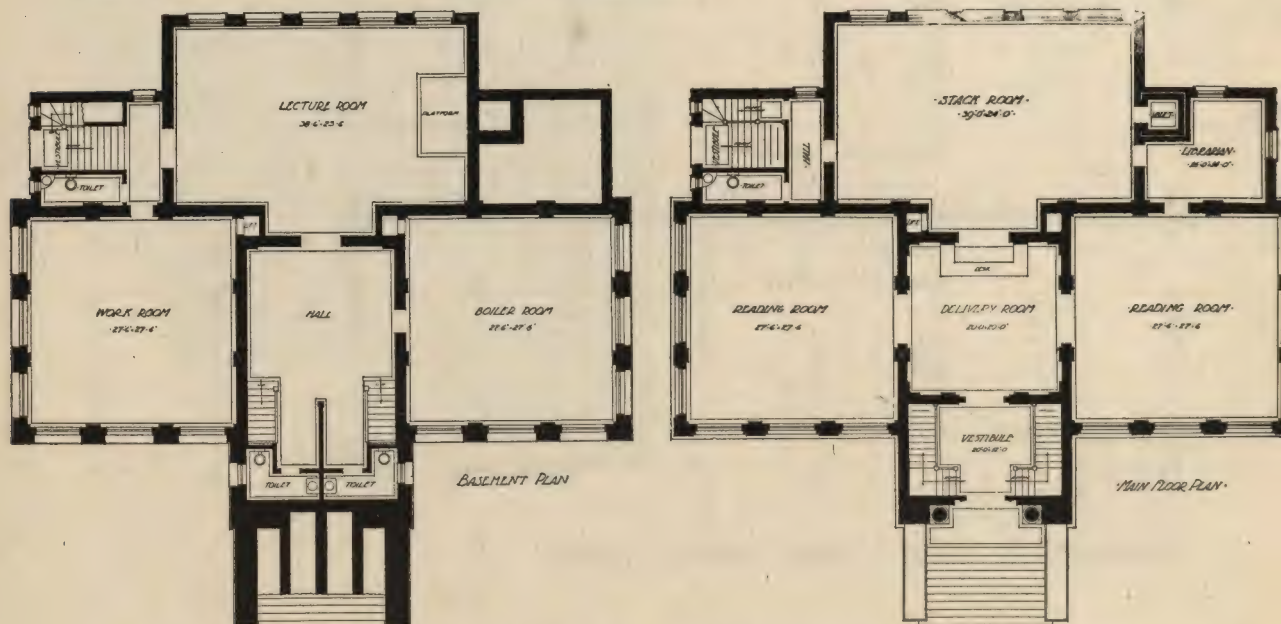
Design No. 75-S

SMALL PUBLIC LIBRARY

Size: Width, 80 feet; Length, 68 feet

Blue prints consist of basement plan, main floor plan; all necessary elevations and necessary interior and exterior details.

Specifications are typewritten and contain information necessary for the proper construction of the building. Price of Plans and Specifications furnished on application.



This is a well designed Modern Public Library, so arranged as to utilize all the space. The design is modest, yet attractive and convenient and would prove a valuable addition to any city. The basement is exceptionally well planned and well lighted, providing a good sized lecture room.



Design No. 661-S

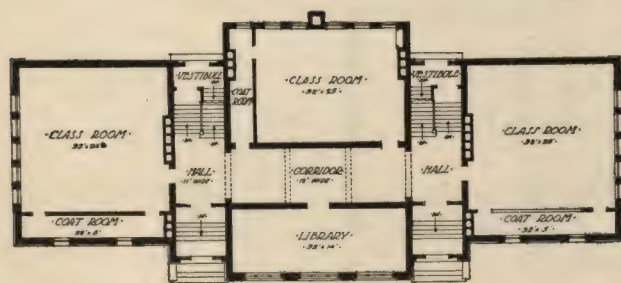
SMALL HIGH SCHOOL

Size: Width, 132 feet; Length, 56 feet

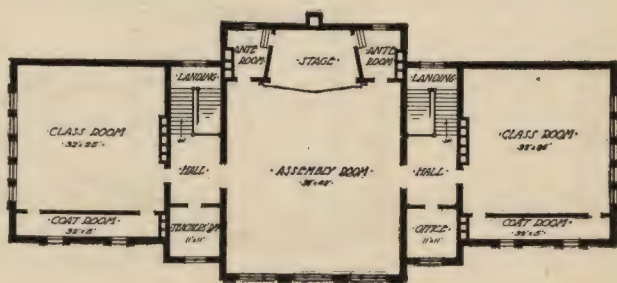
Blue Prints consist of foundation plan, first and second floor plans; all necessary elevations and necessary interior and exterior details.

Specifications are typewritten and contain all information necessary for the proper construction of the building.

Price of Plans and Specifications furnished on application.



First Floor Plan



Second Floor Plan

This is a Good Design for a Small High School

The assembly room affords the particularly interesting part of this small high school. Placing this assembly room upon second floor results in not only high walls and ceiling for the room itself, insuring ample air space, but also makes it possible to add materially to the architectural effect of the exterior.

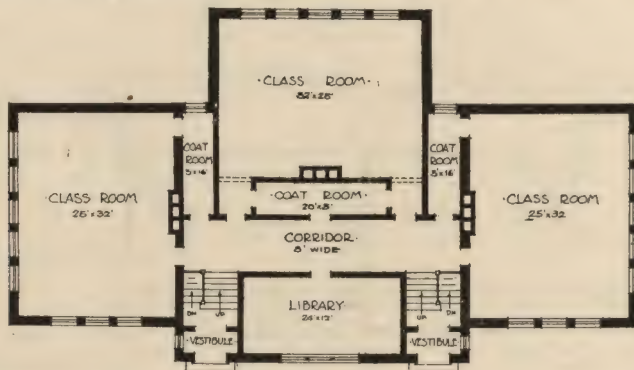


Design No. 321-S

THREE-ROOM VILLAGE SCHOOL

Size: Width, 98 feet; Length, 55 feet

Blue Prints consist of basement plan; floor plan; all necessary elevations and necessary interior and exterior details. Specifications are typewritten and contain all information necessary for the proper construction of the building. Price of Plans and Specifications furnished on application.



Main Floor Plan

Venerable as was the "Little Red Schoolhouse" where the birch rod formerly held sway, that historic relic which laid our fathers under tribute is fast becoming a mere memory. A structure built on broader lines and with a more intelligent eye to the increasing complex educational needs of a later generation, is taking its place.

In the accompanying perspective and floor-plan of a school building for a suburban or rural district, we find a perfect adaptation to the most advanced modern ideals combined with conformity to limitations of moderate cost—an up-to-date Public School Building—adapted to classroom use and community gatherings.

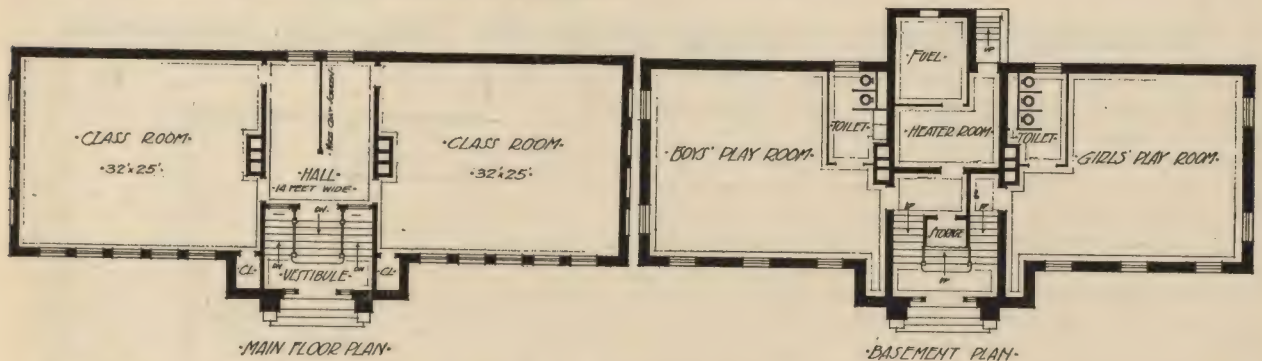


Design No. 250-S

MODERN RURAL SCHOOL

Size: Width, 82 feet; Length, 32 feet

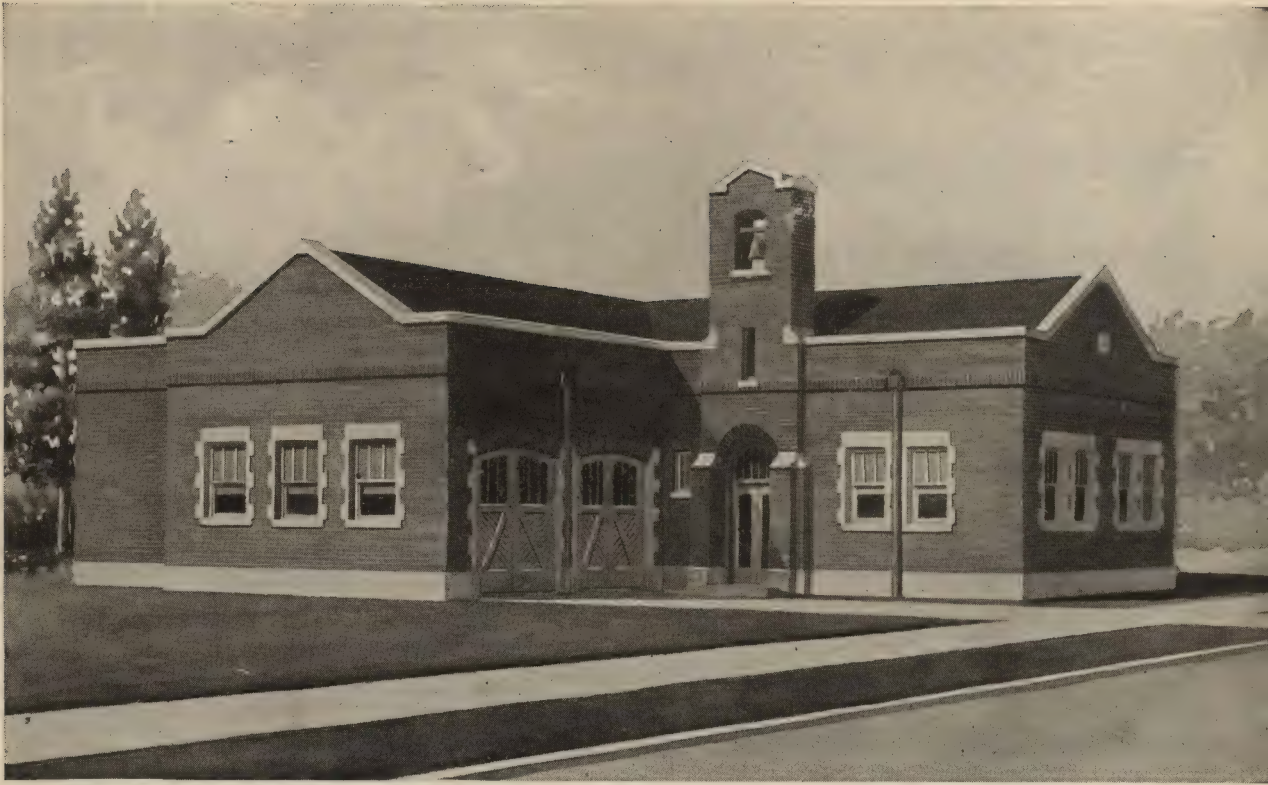
Blue Prints consist of basement plan; floor plans; all necessary elevations and necessary interior and exterior details. Specifications are typewritten and contain all information necessary for the proper construction of the building. Price of Plans and Specifications furnished on application.



What may be considered the interesting feature of this modern country school building, is that the basement space has been made use of for both boys' and girls' play rooms.

A decidedly unique idea in buildings of this size—and it is a very practical and sensible plan.

Note by reference to the floor plans the concise arrangement with ample room and light allowed.



Design No. 26-S

VILLAGE OR TOWN HALL

Size: Width, 49 feet; Length, 62 feet 6 inches

Blue Prints consist of foundation plan; floor plan; all necessary elevations and necessary interior and exterior details.

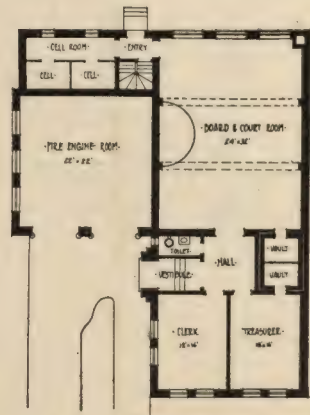
Specifications are typewritten and contain all the information necessary for the proper construction of the building.

Price of Plans and Specifications furnished on application.

Substantial Building of Strong Design for Village or Town Hall

The design shown is an example of what may be accomplished, by skillful planning, for even so unpromising a building as a small size Village or Town Hall—which has to provide accommodations not only for the village officials and the court but also for the village fire department and the lock-up. Such a building is usually anything but an improvement to the looks of the street on which it stands, resembling more a livery stable or barracks than an important public building. The two widely separated requirements of a structure of this kind make it a hard problem of design, especially in view of the fact that the cost usually has to be kept very low.

In this design the architect has solved the problem very satisfactory by placing the fire equipment room and the lock-up in the ell at the rear of the building; the offices are at the front, with the court room immediately back of them. The building as a whole presents a very dignified appearance. It is constructed of dark brown brick with Bedford stone trimmings.





Design No. 3003

Lutheran Church

with a seating capacity of 175

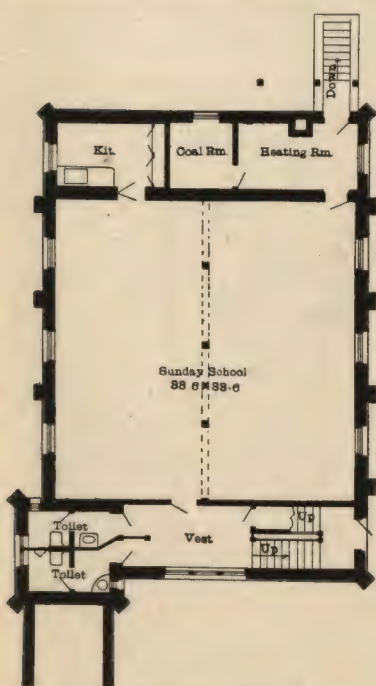
Size: 39 x 54 feet

A brick church with stone trimmings. A good design. There is abundant vestibule space and separate entrances to the basement.

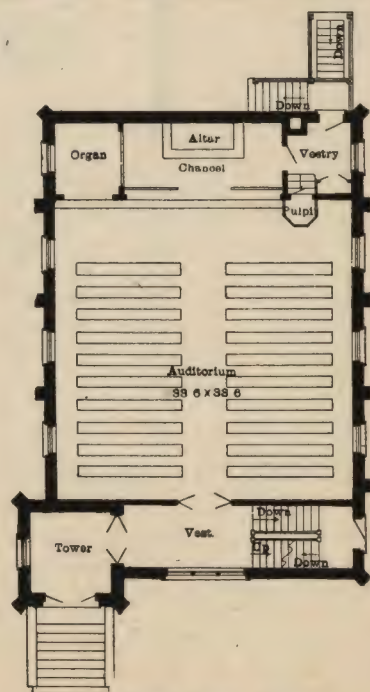
Approximate cost from \$5,500 to \$6,000.

Price of Blue Printed Plans and Complete Set of Specifications,

\$120.00



Basement Plan



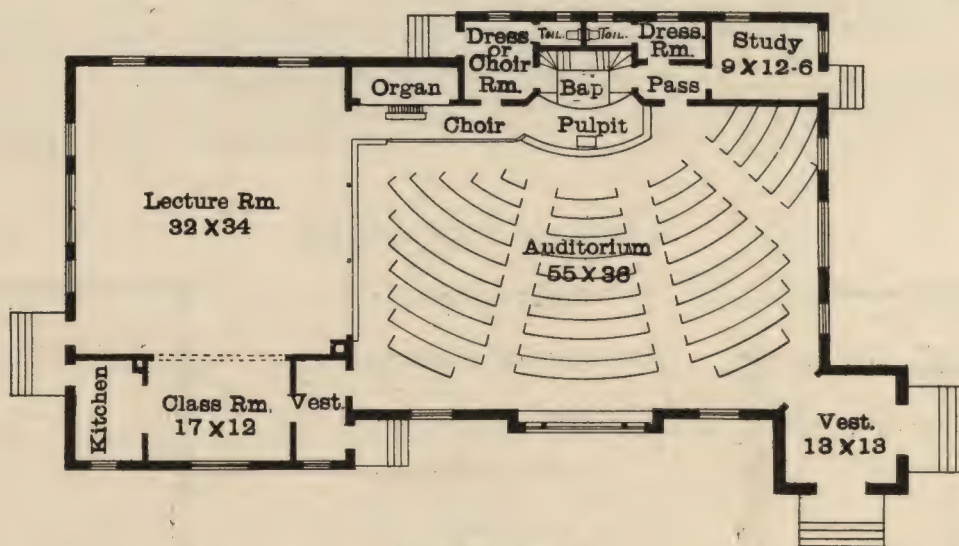
Main Floor Plan.



Design No. 3021

Baptist Church with a seating capacity of 270

A fine building, in the Italian style, particularly adapted for a corner lot. Well arranged floor plan. Cost from \$10,000 to \$11,000.

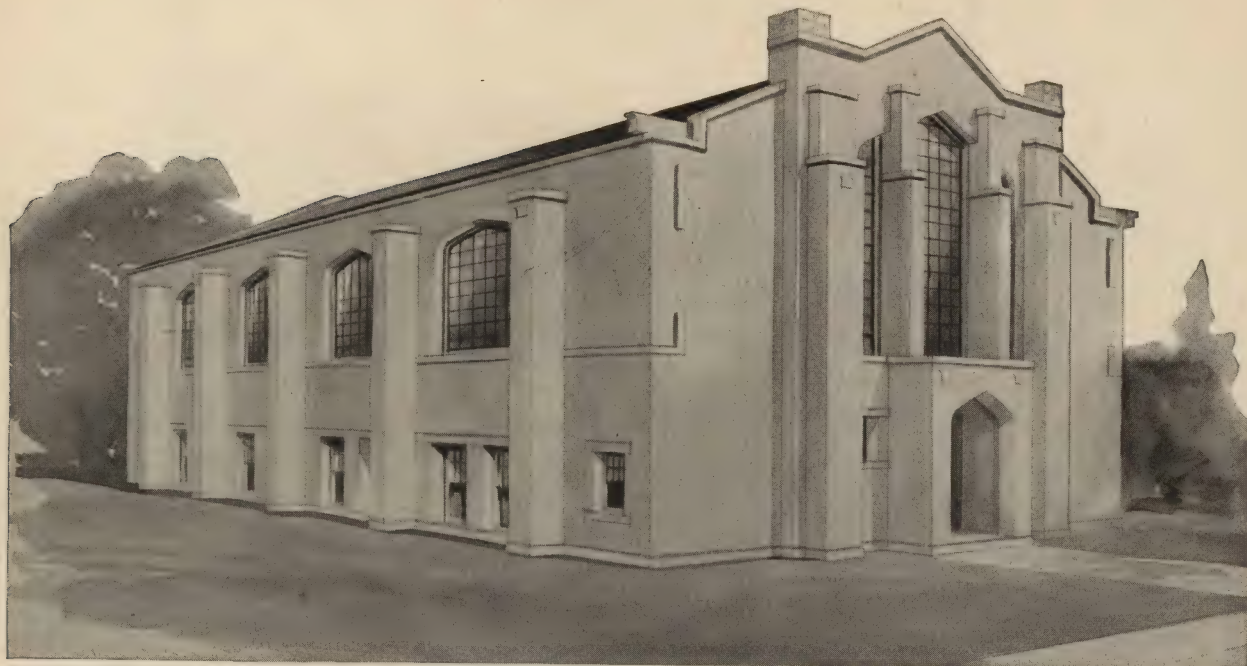


Main Floor Plan.

Size: 57 x 99 feet

Price of Blue Printed Plans and Complete Set of Specifications,

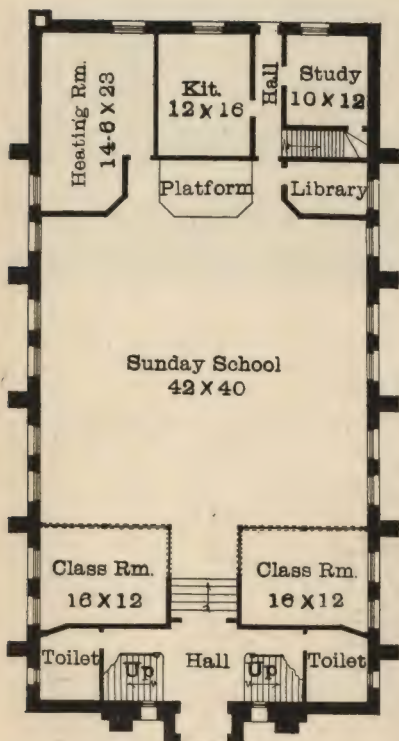
\$115.00



Design No. 3007

Unitarian Church with a seating capacity of 440

Size: 50 x 97 feet



Basement Floor Plan

This two-story brick building is unusually well planned and has a fine modern exterior. Cost from about \$12,000 to \$15,000.

Price of Blue Printed Plans and Complete Set of Specifications,

\$75.00



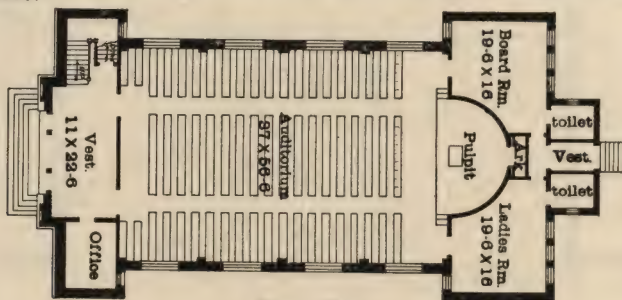
Main Floor Plan



Design No. 3022

Jewish Temple with a seating capacity of 390

An appropriate design for an inside 50 foot city lot. Auditorium is well lighted from the sides. Approximate cost from \$15,000 to \$20,000.



Floor Plan

Size: 50 x 96 feet

Price of Blue Printed Plans and Complete Set of Specifications,

\$200.00

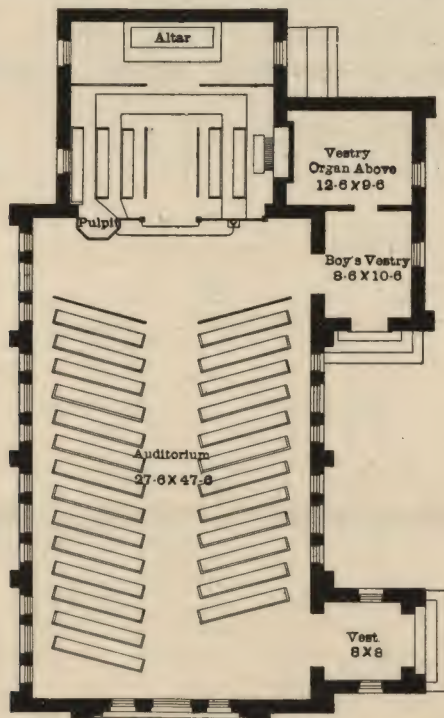


Design No. 3026

Episcopal Church with a seating capacity of 160

Size: 42 x 71 feet

A brick church trimmed with stone. A very attractive design and good plan. Approximate cost from \$9,000 to \$9,500.



Floor Plan

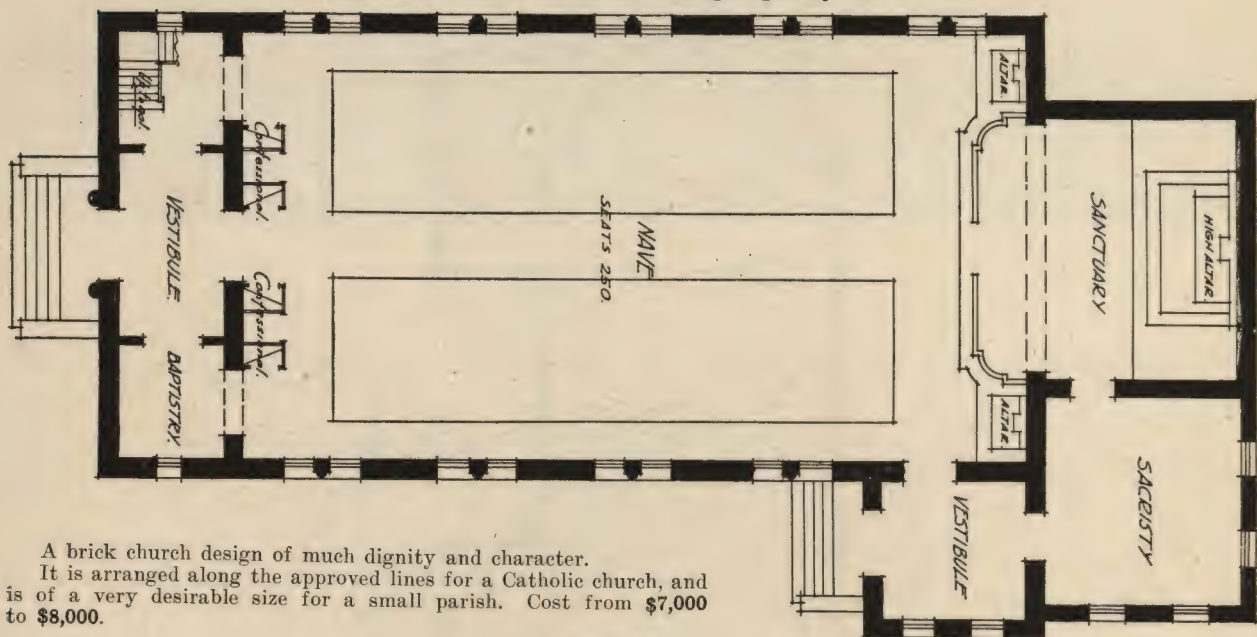
Price of Blue Printed Plans and Complete Set of Specifications,

\$80.00



Design No. 3060

Catholic Church with a seating capacity of 250



A brick church design of much dignity and character. It is arranged along the approved lines for a Catholic church, and is of a very desirable size for a small parish. Cost from \$7,000 to \$8,000.

Floor Plan

Size: 44 x 80 feet

Price of Blue Printed Plans and Complete Set of Specifications,

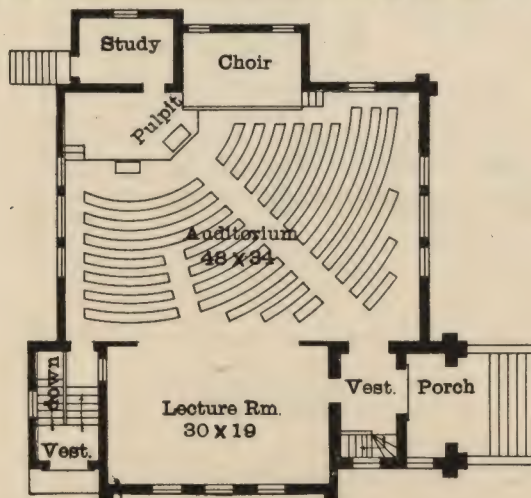
\$120.00



Design No. 3050

Congregational Church with a seating capacity of 215

A fine brick and stone building. Very imposing exterior and convenient floor plan. Cost from \$8,000 to \$9,000.



Floor Plan

Size: 58 x 65 feet

Price of Blue Printed Plans and Complete Set of Specifications,

\$150.00

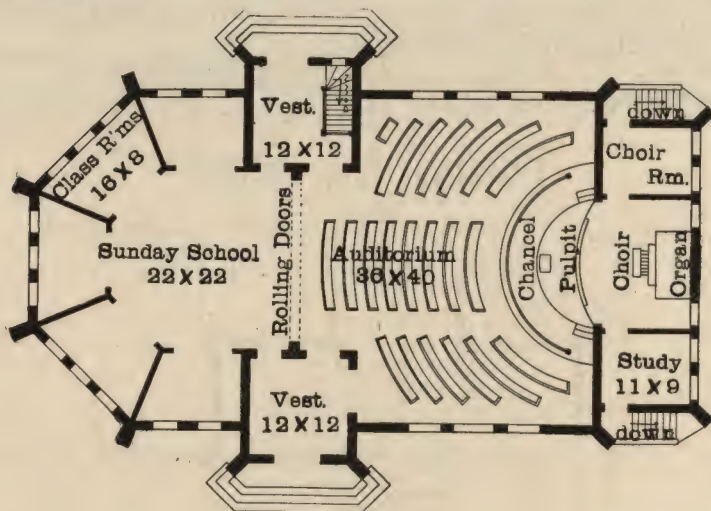


Design No. 3031

Methodist Church with a seating capacity of 150

Size: 42 x 81 feet

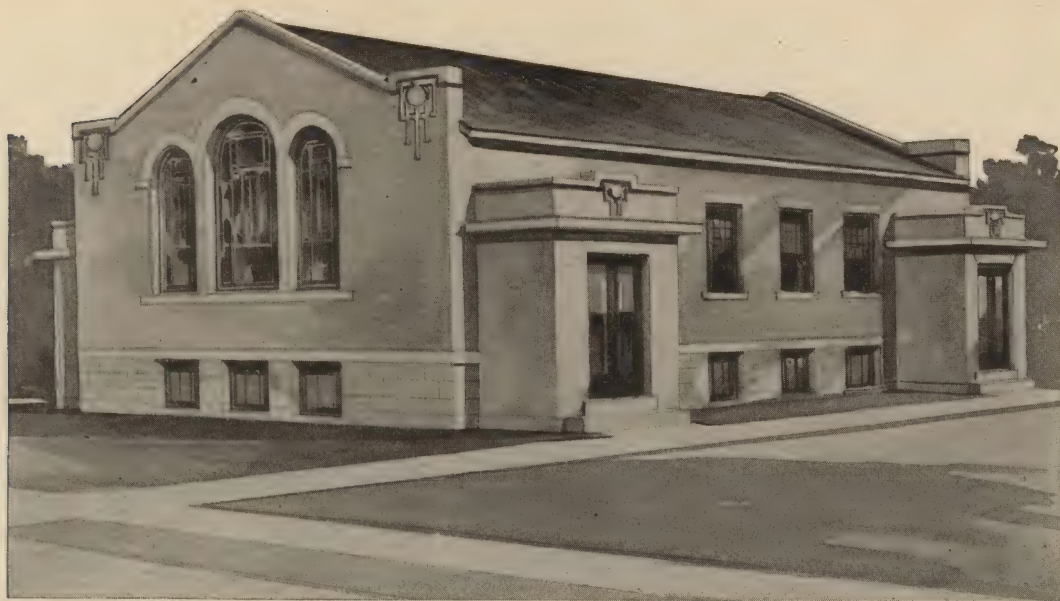
An unusually attractive design of brick with stone trimmings. Approximate cost from \$7,500 to \$8,000.



Price of Blue Printed Plans and Complete Set of Specifications,

\$80.00

EXCHANGING PLANS. If returned in good condition within 30 days we will exchange any set of plans, applying full price on any other set desired.

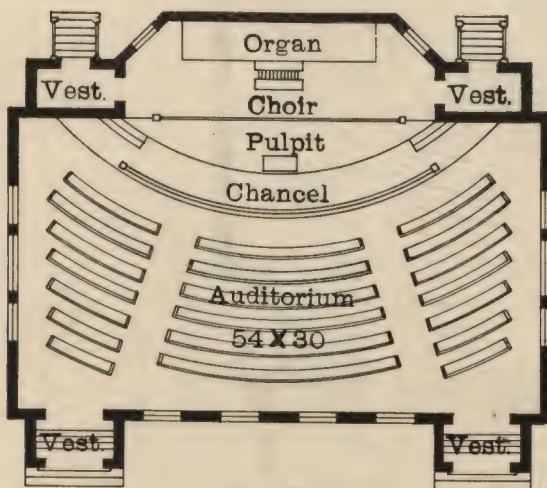


Design No. 3027

Methodist Church with a seating capacity of 200

Size: 56 x 47 feet

A modern brick building, with room for Sunday School in basement if so desired. Approximate cost \$7,500 to \$8,500.

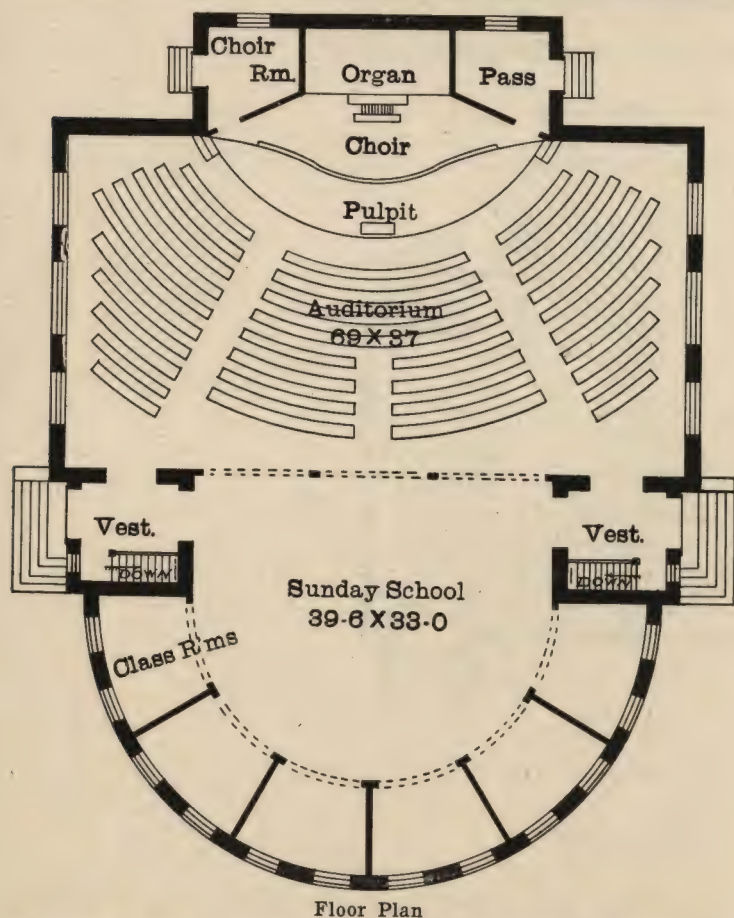


Floor Plan

Price of Blue Printed Plans and Complete Set of Specifications,

\$80.00

PLANS FROM YOUR OWN SKETCHES. Our skilled architects will prepare at lowest cost finished plans embodying your ideas. Write us for full particulars.



Design No. 3029

Presbyterian Church
with a seating capacity of 375

Size: 72 x 96 feet

A very imposing edifice with
twin towers. To be built of
brick and stone. Cost from
\$15,000 to \$18,000.

Price of Blue Printed Plans
and Complete Set of Specifica-
tions,

\$160.00

ALTERATIONS. We can change any plans to suit your requirements, at a reasonable extra charge depending on amount of work involved.

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4001	196	\$15.00	\$6,000.00	\$7,000.00
4003	193	15.00	4,300.00	5,000.00
4006	197	15.00	4,500.00	5,100.00
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9558	170	44.00	10,800.00	11,200.00

CHURCHES, SCHOOLS, ETC.

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75-S	200	Small Public Library.
250-S	203	Modern Rural School.
321-S	202	Three-Room Village School.
661-S	201	Small Modern High School.
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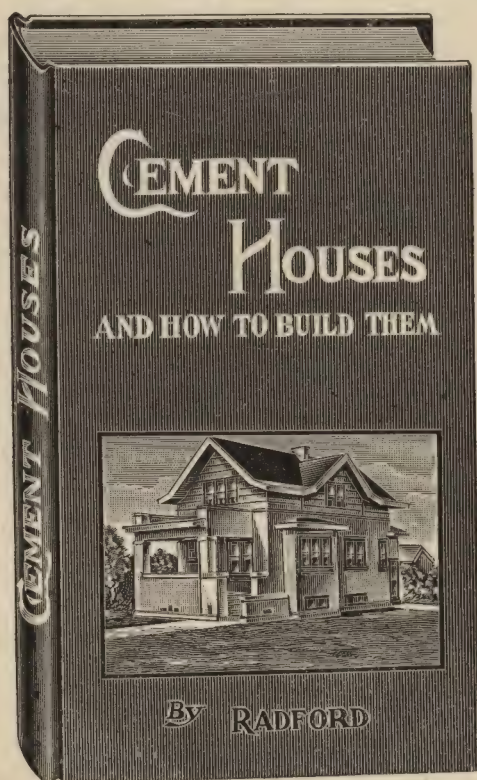
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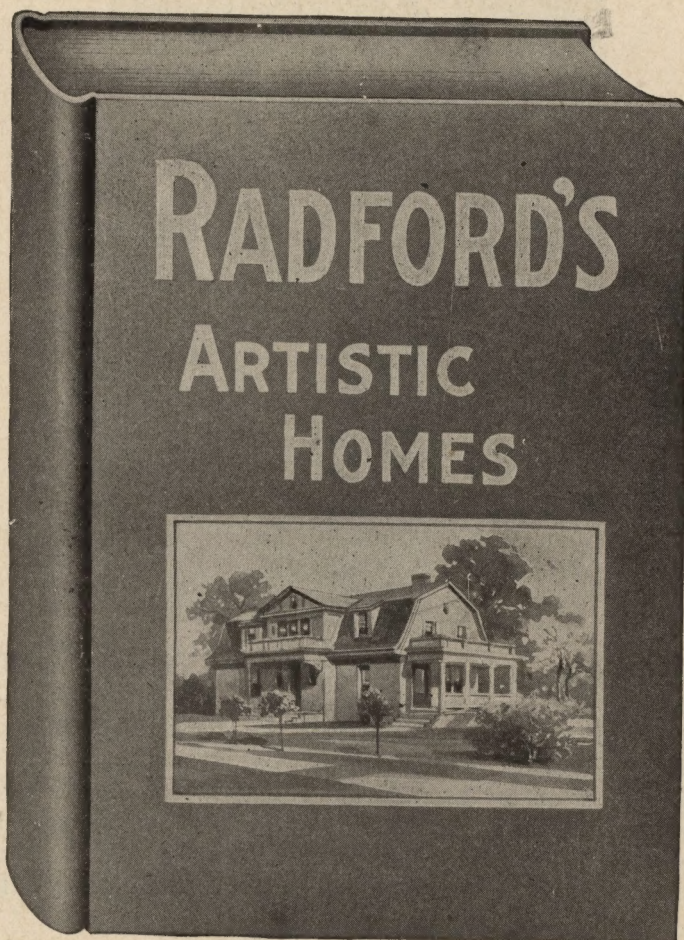
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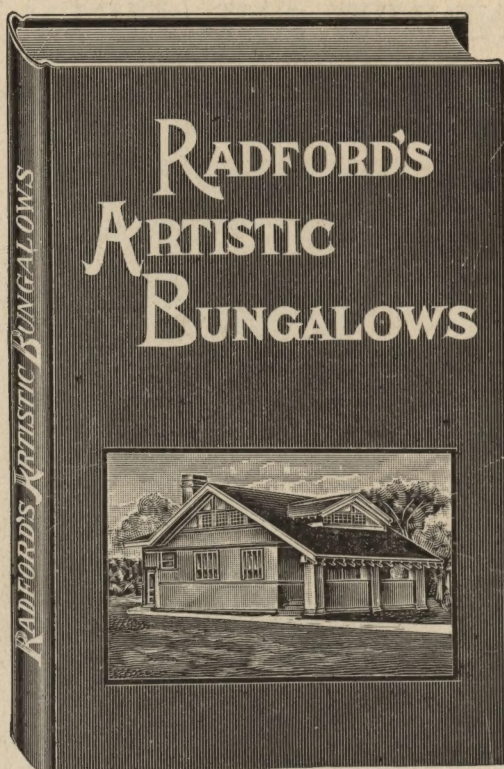
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